Surveying and Mapping

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Quarterly Journal

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GEORGE TOWN
POTOMAK RIVER
EASTERN BRANCH
PART OF VIRGINIA WITHIN THE TERRITORY OF COLUMBIA.
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Pl. I.V
of the CITY of
Washington
in the Territory of Columbia,
ceded by the States of
VIRGINIA and MARYLAND
to the
United States of America,
and by them established as the
SEAT of their GOVERNMENT,
after the Year
MDCCC.
OBSERVATIONS
explanatory of the
Plan.
I. THE ground for the different Reserves, and for the several Squares or, Areas of different shapes, as they are laid down, were first determined on the most advantageous ground, commanding the most extensive prospects, and the better susceptible of such improvements, as either are or commonly may hereafter call for.
II. LINES or, Avenues of direct communication have been devised, to connect the separate and most distant objects with the principal, and to pervade through the whole a reciprocity of sight at the same time. Attention has been paid to the passing of these Avenues, Avenues over the most favorable ground for prospect and convenience.
III. NORTH and South lines intersected by others running due East and West, make the distribution of the City into Streets, Squares, &c. and these lines have been so combined as to meet at certain, open points with those diverging Avenues, so as to form on the Squares, first determined, the different Squares or, Areas
SCALE OF POLES.
Breadth of the Streets.
THE ground Avenues, and such Streets as lead immediately to public places, are given 160 to 400 feet wide, and may be conveniently divided into five ways, walks of trees, and a carriage way. The other Streets are from 90 to 110 feet wide.
IN order to execute this plan, Mr. ELLICOTT drew a true Meridional line by celestial observation, which passes through the Area intended for the Capitol, this line he copied by another due East and West, which passes through the same Area. These lines were accurately measured, and made the bases on which the whole plan was executed. He ran all the lines by a Transit Instrument, and determined the whole Angles by actual measurement, and left nothing to the uncertainty of the Compass.

Jan. • Feb. •
Mar. • 1952

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A Message From President Harding

THE American Congress on Surveying and Mapping has now been in existence for over ten-and-a-half years. Created as the result of a real need existing in the profession during the hectic period just prior to World War II, it has survived *and grown* in spite of the disruptions to the normal lives of our members occasioned by the war.

Without the continued interest and loyalty of both the members and officers of the Congress during this protracted period of uncertainty the growth or even continuance of the Congress would have been impossible. Another factor indispensable to the increasing growth and success of the Congress is the firm belief, so steadfastly held by our officers and by the vast majority of our members, that the Congress is a necessity if the profession is to be advanced and standards raised within a reasonable length of time.

The work of the Congress has, however, in reality, just begun. The large numbers of potential members who should be participating and helping those already in the Congress to accomplish its objectives constitute an ever-growing challenge. The more active participation of more of our members in the annual meetings, in Technical Division efforts, and in local sections, both existent and to be created, will mutually benefit both the Congress as an organization and the individuals themselves. The creation of new technical divisions as needed, and the problem of regional meetings to be held in different parts of the country are both matters requiring considerable thought and planning.

The American Congress on Surveying and Mapping has been unusually fortunate in its choice of men whom it has selected from the time of its inception to lead its activities. Its Presidents, officers, and Boards of Direction have devoted much time, with telling results, in bringing the Congress to its pr sent state of success.

As President-elect of the Congress for 1952, I am deeply appreciative of the honor conferred upon me by election to this office. At the same time I am aware of the responsibility which that office carries with it in meeting the standards established by my predecessors. The officers of an organization such as the Congress are dependent upon the cooperation and support of its members for any success which the organization may accomplish during any administration.

Speaking for the officers and Board of Direction, I pledge to you, the members, our very best efforts; but we will need your active cooperation, your suggestions, and your contributions of both time and effort to make 1952 a year of accomplishment, equal to and perhaps even better than past years. Unless each year can show some improvement over the past, the organization itself is not progressing. The high standards already established constitute a challenge to us in 1952 to add another stage of growth and improvement. This can be done with the help of each individual member. Will you help us by doing your part? If you will, we can all be confident of the result.

GEORGE H. HARDING,
President

The Modern Mission of Geodesy

By W. O. BYRD

MAPPING AND CHARTING RESEARCH LABORATORY, OHIO STATE UNIVERSITY RESEARCH FOUNDATION

EDITOR'S NOTE.—The following papers by Mr. Byrd and Dr. Heiskanen were presented at the plenary and technical sessions, respectively, of the Control Surveys Division presided over by R. M. Wilson, Chairman. A prepared discussion by Lansing G. Simmons follows, as well as a comment by W. O. Byrd on Mr. Simmons' discussion.

THE IMPORTANT ROLE of geodesy in the development and growth of our civilization is still little understood or appreciated. A few people, such as the group assembled here this evening, who are actively engaged in some kind of geodetic surveying, do, of course, realize the value of their work. But one often wonders whether he sees the real geodetic forest or simply the individual trees which block his view.

The modern geodetic mission is breath-taking in its challenge. We are living on a globe considerably shrunken, insofar as time of traversing from one point to another is concerned, due to modern transportation and communication facilities. Also, the interrelationships and interdependencies of peoples and economies and other geographic phenomena are thoroughly established and appreciated today.

This afternoon you heard very capable speakers point out the importance of surveying and mapping in developing the economy of nations, in promoting international good will, and in the interests of National Defense, so we shall not dwell on these considerations. Suffice it to say here that the need for maps is great and urgent, that geodetic control is an essential foundation for maps to assure coverage without overlaps and gaps and to prevent costly remapping, and, that it is only a policy of common sense to built the foundation first and to build it solidly for permanence.

This simple criterion of precedence and durability in geodetic requirements (the foundation control must precede the mapping, which in turn must precede developmental progress) places a heavy responsibility for farsighted leadership upon those in charge of geodetic operations.

As we all know that only a small fraction of the land area of the earth is adequately covered by surveys and maps and that civilian and military defense pressures for getting on with the job are urgent, let us quickly see whence we came and at which milepost we have arrived, geodetically speaking, in order to gain proper perspective.

THE FIRST TWO GEODETIC ERAS

Not reckoning as a period in geodesy the times in which primitive notions existed that the earth is a flat surface or a disk, the first, or spherical era, of geodesy held sway for 2,000 years, from about the time of Aristotle. Eratosthenes of Alexandria, in the 3rd century B. C., made the first known determination of the size of the earth based on the spherical principle of exact correspondence between angular distances in the heavens and linear distances on the earth.

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In the late 17th and first half of the 18th centuries the oblateness of the earth was questioned and studied. The works of Newton and Huyghens in this connection ushered in the second, or spheroidal era, of geodesy.

For 300 years now, since Picard first used the telescope for triangulation, instruments and techniques for geodetic surveying have evolved into those in use today. The use of the telegraph, and later of the radio, in longitude determinations, were noteworthy forward steps. Many separate triangulation systems gradually grew into being with a slight time lag behind the needs for economic development and military defense.

During the 19th century many investigators determined the size and shape of the earth, chiefly by means of meridian arc measures, on the assumption that it was an ellipsoid of revolution, commonly referred to as a spheroid. These determinations generally differed slightly from one another depending on the location and reliability of the data used, but were quite adequate for local control and mapping purposes.

Perhaps the greatest single achievement of the spheroidal era was made by Hayford, early in this century, when he determined dimensions of the ellipsoid which were later adopted for the International Ellipsoid of Reference. Two outstanding features of Hayford's work are the area method of computation, as distinguished from the arc method, and the practical application of the geophysical hypothesis of isostasy. A recent monumental accomplishment of this era, largely due to the untiring efforts of Col. Floyd W. Hough, is the attainment of homogeneity in the triangulation of Europe.

THE THIRD ERA OF GEODESY

We come now to the third era of geodesy which no doubt will prove to be the most exciting and satisfying of all. We are just entering this period now, and shall call it the geoidal era. Heretofore, geodesists, in effect, have been forced to observe and measure on one surface, the geoid, and to use these measures without appropriate transformations for computing and specifying positions on another surface, the spheroid. This has been so, not by choice, but rather because of a lack of information concerning the relation between the geoid and the spheroid.

The transition in geodetic thought—from the local to the world point of view, and from spheroidal to geoidal concepts—has become increasingly evident during the past quarter century. Many charts have been prepared purporting to show geoidal contours with respect to the spheroid. Also, geodesy has become more intimately associated with geology and geophysics, with many mutual resultant benefits.

THE MODERN GEODETIC MISSION

No spheroid will exactly fit the mean sea-level surface which is called the geoid. The slight deviations between the two surfaces are accounted for by the geoidal anomalies of gravity and the deflections of the vertical. For this reason we have the two classes of geographic positions known as geodetic and astronomic positions.

Reconciling these two kinds of geographic positions is one of the major tasks of geodesy today. The ultimate aim is the placement of all the geodetic control of the world on one ideal geodetic datum. When this has been done, specifications for map control positions will not require a certain accuracy "with

respect to the *nearest* first-order control'' but rather ''with respect to the World Geodetic System.'' The spheroid will then become a true reference surface in fact, rather than, incorrectly as at present, in name only.

Stated differently, the modern geodetic mission is two-fold: first, the determination of the size and shape of the geoid, and second, the determination of the location of the physical surface of the earth with respect to the geoid as evidenced by the familiar networks of position monuments and elevation bench marks.

ACCOMPLISHING THE GEODETIC MISSION

To accomplish this mission expeditiously, it would seem prudent to prepare careful estimates of control needs—accuracies, spacings, and schedules—to inventory our geodetic tool kit of instruments and procedures, to ascertain the peculiar fitness of each, and to reexamine our conventional concepts in the light of the new era.

Take, for instance, the well-known concept of using progressively less accurate control as the spacings are reduced, wherein areas surrounded by first-order surveys are divided into smaller areas by second-order surveys which, in turn, are further divided by third-order surveys. Can this principle be extended to the earth as a whole? Can supercontrol points be established at, say, intervals of 2,000 miles to 6,000 miles, to control the first-order triangulations? In my opinion, such points can and will be established within the next decade. The gravimetric-astronomic and star-occultations methods are both available for this purpose, and require only polishing and determined application to become effective.

Indeed, with supercontrol points, cannot some of the required first-order triangulation surveys be dispensed with and replaced by more rapid but less accurate techniques, in order to expedite the end products? Remember, these products should be obtained with a minimum of expenditure in cost and effort and the investment should be justified economically. The savings in time, cost, and effort thus effected might then be devoted to precise surveys for urban and industrial developments.

Many new and powerful geodetic tools have been developed during the past 25 years, but it must be noted that the potentialities of several are not now being fully exploited. One example is electronic mensuration, such as Shoran. We might well emulate our Canadian friends and put this tool to more use.

Another example is the gravity-survey method which Dr. Heiskanen describes in his paper. Even today, 28 years after Dr. Vening Meinesz invented the pendulum apparatus for making gravity measures at sea, no organized comprehensive oceanic survey for geodetic purposes has been undertaken.

THE FUTURE OF GEODESY

What about the future of geodesy?

Great opportunities and responsibilities for service exist now, and their number will continually increase, and the end results will enjoy an ever wider appreciation. Geodesy must march forward to keep pace with the other earth sciences.

There is, however, no easy royal road ahead. Even with the tools of modern science and technology, much ingenuity and hard work are required. And above all, bold imaginative leadership of the Hayford stature is necessary to carry us forward.

The Role of Gravimetry in Geodesy

By DR. W. A. HEISKANEN

DIRECTOR, FINNISH GEODETIC INSTITUTE AND SCIENTIFIC DIRECTOR, INSTITUTE OF GEODESY, PHOTOGRAMMETRY, AND CARTOGRAPHY, OHIO STATE UNIVERSITY

THE MOST IMPORTANT PROBLEMS of geodesy are to determine the size and shape of the geoid, to convert the existing geodetic systems of different countries to the same *World Geodetic System*, and to supply the needed control points for mapping.

Up to now it has not been possible to solve all these problems. The geodesist's difficulty is that he must carry out his geodetic computations along one surface, the *reference ellipsoid*, while he makes his measurements along another surface, the *geoid* (or sea-level surface). His astronomic measurements are referred to the geoid, he reduces gravity measurements to the geoid, and he measures elevations with respect to the geoid. He knows that these two surfaces do not agree but he has had to neglect the deviations between these two surfaces because he has not been able to determine them with sufficient accuracy.

The general procedure in geodesy has been the following: We execute the triangulation survey and, at one of the stations, we make astronomic observations to determine the latitude ϕ_o', longitude λ_o', and the azimuth A_o' to another station. Starting from this *initial point* we compute along the reference ellipsoid the coordinates, ϕ and λ, of the successive triangulation points and the azimuths, A, of the various lines. These geodetic coordinates are referred to the adopted ellipsoid and they will be used as control points for subsequent mapping.

If, also, the corresponding astronomic coordinates ϕ', λ', and the astronomic azimuth A' have been observed, at several triangulation points, we have the *arc measurement*. The astronomic quantities refer to the geoid, because the spirit level is parallel to the geoid. The angle between the normal of the adopted ellipsoid and the normal of the geoid or the plumb line is, by definition, the *deflection of the vertical*. The following well-known equations give the meridian component ξ and the east-west component η of the deflection of the vertical:

$$\begin{aligned} \xi &= \phi' - \phi \\ \eta &= (\lambda' - \lambda) \cos \phi, \text{ or} \\ \eta &= (A' - A) \cot \phi \end{aligned} \qquad (1)$$

Up to now, nearly every country has had its own geodetic system because different initial points and, also in some cases, different reference ellipsoids have been used. The coordinates of the control points of each country and the values of ξ and η are referred to its particular system. These systems, even the systems of neighboring countries, are usually quite different. For instance, the discrepancy between the Danish and German geodetic systems is 6″.3 in latitude and 8″.9 in longitude; between the English and French systems 5″.4 in latitude and 4″.0 in longitude. Still worse is the fact that we do not always know the values of the differences between the geodetic systems.

In order to have a geodetic system, we must know at least five basic quantities: the equatorial radius a and the flattening α of the adopted reference ellipsoid, the latitude ϕ and longitude λ of the initial point, as well as the azimuth A

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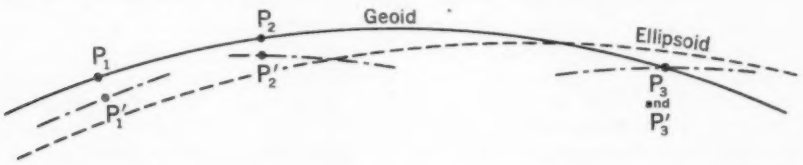
from the initial point to another point. If only one of these five quantities changes, the entire geodetic system changes too. Your famous countryman, John F. Hayford, as long as four decades ago computed the quantities a and α of the reference ellipsoid, which under the name of the International Ellipsoid, is being used in most countries. We have to continue his work and determine properly the remaining three quantities and also the height N of the geoid at the initial point referred to the ellipsoid.

Only in this way can we standardize the geodetic operations and rid ourselves of the confusion brought about by the many different systems. So far it has been only partly possible. The described astronomic-geodetic method does not give and cannot be made to give absolute values for the deflections of the vertical or for the undulations N of the geoid.

Owing to this fact, the geoid fragments which have been computed in the United States, in India, and in many European countries are in general not parts of the geoid, because we do not know (see accompanying figure) the relative elevations of the adopted ellipsoid and the geoid, or how much the geoid is tilted with reference to the ellipsoid. We obtain the *shape* of the geoid in these regions but not the geoid itself. Besides, the arc-measurement method has the drawback that it fails completely over the oceans.

To convert existing geodetic systems to one World Geodetic System, including cases where the initial points are on different sides of the oceans, we must use the *gravimetric method*. The *mathematical basis* of this method was published over 100 years ago by the famous English scientist G. G. Stokes.



The profile fragments (— — — —) through the initial points P_1', P_2' and P_3' have been computed by the aid of arc measurements. The points P_1' and P_2' have been uplifted above the reference ellipsoid (— — — — — —); the point P_3 happens to be at the geoid (————). These profiles can give the shape of the local geoid, but the figure shows that they are not parts of the *real geoid*, because we do not know the real undulations N nor the deflection-of-the-vertical components, ξ and η, at the initial points P_1, P_2, and P_3. Only the gravimetric method is able to furnish us with these important quantities N, ξ, and η and convert the profile fragments to units of the real geoid. The quantities N, ξ, and η indicate, in fact, how much we have to tilt the local profiles and either raise or lower their initial points in order to convert them to the geoid.

The *geophysical basis* for this method is the fact that the gravity anomalies Δg, the undulations N of the geoid, as well as the components ξ and η of the deflection of the vertical have the same cause, namely, the disturbing mass layers of the earth. Of these quantities the gravity anomalies Δg, as referred to the adopted gravity formula, can be observed; the remaining quantities N, ξ, and η can be computed by the aid of Δg. This is the only method that will give us the absolute values for these three important geodetic quantities.

Some attempts have already been made in this direction. F. A. Vening Meinesz in 1928 derived from Stokes' equations practical formulas for computing gravimetrically the components of the deflection of the vertical. J. de Graaff-Hunter in 1935 studied this problem theoretically. R. A. Hirvonen in

1934 computed the continental undulations of the geoid at about 100 points and L. Tanni in 1948 at more than 200 points, girdling the earth, with the aid of the data they had available. D. A. Rice in 1948 computed the absolute deflection of the vertical at some American points. Success, however, has not yet been complete, because we have not had sufficient gravity anomalies in all parts of the world. The formulas of Stokes and Vening Meinesz presume that we know pretty well the gravity anomalies in the neighborhood of the points where these quantities must be computed, and in broad lines all over the world.

It is true that there are several hundred thousand gravity stations in the world. They have, however, been measured for geophysical, geological, or prospecting purposes or by chance, so that they are not useful for our geodetic purpose. In many areas there are more gravity data than are necessary for our purpose. On the other hand, there are large areas, and not only in the oceans, without any gravity measurements at all. This is why we must still carry out additional regional gravity measurements on the continents as well as at sea, and also make local surveys in many places of the world before we can obtain as accurate values for the quantities N, ξ, and η as are desirable. We may possibly be able to get these additional data very soon, perhaps even in the course of 1 or 2 years.

Supposing that we have all these data, we can compute the quantities N, ξ, and η at any point in the world where the necessary local gravity survey exists. At the present time, such areas do exist, as, for example, large parts of Europe, the United States, Canada, and India, where this can be done right now. According to the computations carried out up to now, the accuracies of about 2 meters in the computation of N and $0''.5$ to $0''.7$ in ξ and η are possible.

We can therefore convert all existing geodetic systems to the one World Geodetic System. We have only to compute the absolute quantities N, ξ, and η, at the initial points of the different systems. In this way, we know how much we have to tilt different existing systems and how many meters to raise or lower their initial points in order to place these systems properly on the geoid.

At all such points where astronomic observations have been carried out, we can convert the astronomic coordinates from the geoid to the ellipsoid. We have only to reverse the formulas (1) and write them in the following way:

$$\begin{aligned} \phi &= \phi' - \xi \\ \lambda &= \lambda' - \eta \sec \phi \\ A &= A' - \eta \tan \phi \end{aligned} \tag{2}$$

As we have already mentioned, the quantities ϕ', λ', A' are the astronomically observed values and ϕ, λ, and A, the geodetically computed quantities. The former are referred to the geoid, the latter to the ellipsoid.

The point accuracy obtained in this way is about 30 to 40 meters. Therefore, we can control all maps at scale 1:100,000 and smaller with the aid of this method, even without any triangulation. In fact, 40 meters corresponds on a map of 1:100,000 scale to 0.4 mm. which is just about the drafting and reproducing accuracy. If we think of what large areas of the world, lying in many countries, are still without any triangulation, we can realize the importance of the gravimetric method in controlling the maps of such areas.

If we are interested in computing distances between points that are distant from one another, this can be done very easily by means of coordinates determined from formulas (2) and the known dimensions of the ellipsoid. The error will be approximately $\sqrt{2}$ times the point error, or the mean error of the dis-

tance will be in the order of 50 to 60 meters. It is important to mention that this accuracy does not depend on the distance between the points. It is the same whether they are 50 kilometers apart or if one of them is in the United States and the other in Australia. As we know, in triangulation the greater the distance the less is the accuracy of the distance.

To put it briefly, the gravimetric method can convert existing geodetic systems to the World Geodetic System; it is able to control maps at a scale of 1:100,000 or smaller; it can be used to compute even world-wide distances without connecting triangulation; and, in conjunction with triangulation can give corrections, if needed, to the adopted reference ellipsoid as well.

Because of these decisive geodetic abilities of the gravimetric method and, because of its other scientific importance, we have, in the Mapping and Charting Research Laboratory of Ohio State University, planned a world-wide gravity program which has received a world-wide response. Most leading scientists of geophysical geodesy, as Vening Meinesz, Lejay, de Graaff-Hunter, Hirvonen, Ewing, Woollard, Worzel, and Hess, are planning to cooperate with us, and the eminent American geodesist W. D. Lambert is now a consultant of our laboratory. Many foreign countries as well as some American universities have promised to send gravity expeditions to the oceans and to the different continents. Oil companies and exploration corporations have promised material as well.

Under these auspices our laboratory hopes to be able to achieve the greater part of these goals during the course of the next 3 years.

Discussion

By LANSING G. SIMMONS
U. S. COAST AND GEODETIC SURVEY

INASMUCH as the papers of Dr. Heiskanen and Mr. Byrd both deal with the same general subject, each supplementing the other, one discussion should be sufficient. These papers envisage a broad program directed toward that ideal goal which all geodesists have dreamed of for years. This is the placing of the geodetic control systems of the world on one datum. There are two approaches toward this goal: one involves actual geodetic measurements between control datums, as they now exist; the other is the gravimetric method outlined in the papers.

Available to geodesists are several methods of connecting separate geodetic datums, each having its advantages under certain conditions, as well as its disadvantages.

1. Orthodox triangulation.

ADVANTAGE: direct, accurate observations over land areas.

DISADVANTAGE: distances over water areas are limited to about 200 miles or less in most cases.

2. Airborne Shoran.

ADVANTAGE: distances between stations can approach 500 or 600 miles, permitting extension of control across rather large bodies of water and over inaccessible terrain with a minimum number of stations.

DISADVANTAGE: rather costly and limited in accuracy as compared to orthodox triangulation.

3. Flare triangulation.

ADVANTAGE: similar to airborne Shoran, although the range generally is not as great.

DISADVANTAGES: same as those for Shoran, also unusually good weather conditions are required.

4. Lunar occultation of stars.

ADVANTAGE: ranges up to several thousand miles.

DISADVANTAGES: good weather conditions required; limited in accuracy because of irregularities of the moon's limb and in its motion. When more data on these irregularities are available, the method may prove to be extremely valuable.

5. Solar eclipses.

ADVANTAGE: long range comparable to that for lunar occultations.

DISADVANTAGES: limited accuracy in timing the four contacts between lunar and solar disks. This method also requires good weather conditions and has the great disadvantage of rarity of total eclipses at desirable locations.

6. The use of gravity observations in determining absolute deflections of the vertical.

ADVANTAGES: no limiting range. Coupled with astronomic observations for latitude and longitude, this method will provide accurate positions on the earth's surface without any reference to distance measurements. It must be borne in mind, however, that such a method depends on the adopted spheroid for scale.

DISADVANTAGES: acceptable accuracy depends on an enormous number of gravity observations not now available, especially at sea and in the Southern Hemisphere; the great cost of obtaining these observations and the cartographic detail to make them useful.

Mr. Byrd presents a picture of a system of "super-control" points spaced 2,000 to 6,000 miles. Presumably these points will be tied directly to triangulation stations on existing but separate geodetic datums. The spacing requirements would provide for other points in unsurveyed areas where geodetic control will be established in the future. As has been pointed out, supercontrol points determined by method (6) will produce positions in an angular sense only, that is, by latitude and longitude; they will, in themselves, not determine actual distances on the earth's surface or new dimensions of the spheroid.

It is true, as Dr. Heiskanen points out, that a great many gravity stations have already been observed, but these are confined to relatively small areas of the earth's surface. A world-wide coverage can be considerd scarcely more than started. To replace Vening Meinesz's pendulum apparatus for gravity observations in a submarine, there is an urgent need for some type of gravity meter that will produce gravity values at sea much more rapidly and accurately. The development of such an instrument, in my opinion, is of prime importance and a prerequisite to an intensive campaign of gravity surveys throughout the ocean areas.

Neither paper evaluates the difficult problem of obtaining enough gravity observations properly spaced on the surface of the earth to make possible the ultimate goal. Moreover, no estimate of the number or spacing of gravity observations is made. Not only are gravity observations required throughout the ocean and continental areas, but also for each observation there must be at least a rough determination of elevation, latitude, and longitude. In isolated or unmapped areas of the world, of which there are many, the determination of elevations and positions to a sufficient accuracy is a greater problem than the observations for gravity. I can hardly agree with Dr. Heiskanen that "we may possibly be able to get these additional data very soon, perhaps even in the course of 1 or 2 years."

I believe all are agreed that the best way of getting the details of the geoid in relation to the spheroid is through the gravimetric method. The program outlined in the two papers should have the support of all geodesists. It is certainly a long-range program and can bring about a refinement that should be applied to the geodetic surveys throughout the world but only *after* much more mapping and associated cartographic details have become available.

Comment by W. O. Byrd

THE ONLY REALLY NECESSARY COMMENT on Mr. Simmons' discussion is an expression of sincere thanks for his excellent and kind remarks. A few general points might, however, be emphasized.

A broad geodetic program is envisaged in the original papers which includes, in addition to the ultimate attainment of a single ideal geodetic datum, a decided acceleration of geodetic operations and of world mapping. The demands of the world's economy, to say nothing of military defense requirements, are increasing almost in geometric progression.

The people of the world cannot and will not wait for orthodox triangulation to meet their geodetic requirements. Meagerly controlled photographic surveys are now being used to speed resource development programs. Incidentally, such surveys can also be used for positioning gravity stations.

To accomplish this over-all geodetic mission expeditiously and economically, the advantages of *all* geodetic techniques should be fully exploited *now*—the advantageous use of none should be deferred. It is indeed a dismaying fact that, even today, a century after Stokes introduced the gravimetric-geodetic theory and a quarter of a century after Vening Meinesz invented the oceanic pendulum apparatus, no effective world-wide gravity program for geodetic purposes has been established.

One way to evaluate the relative merits of proposed alternative geodetic procedures is to prepare comparative cost estimates, and then weigh these against the resultant benefits. It would probably be extremely interesting and enlightening, for example, if estimates were made of the cost of the proposed South American geodetic system, both with the usual fortuitous development of the datum and with, say, two astronomic-gravimetrically determined supercontrol points having estimated relative and absolute accuracies of 0".4 and 1".2 respectively.

Two kinds of spacings are contemplated in the gravity survey. The minimum general survey, designed to give the gentle regional undulations of the geoid, would require about 3,000 additional observations spaced at 200- to 400-mile intervals over the whole earth. The density of the observations required for the local surveys, made for the purpose of augmenting the general survey in the vicinity of points at which deflections are desired, would decrease rapidly with the radial distance from the point under consideration. The number of observations in each locality might vary from a hundred to perhaps several thousand, depending on the accuracy sought and the availability of data. Sites which are advantageous due to the topography, the gradient of the gravity field, and the possible acquisition of data would be chosen for supercontrol stations.

The modern geodesist seems to have a somewhat paradoxical nature. He shrinks away from the use of new techniques, even though proved in value, for various reasons concerning costs, accuracies, or the fact that some difficulties are involved, but clings tenaciously and exclusively to the laborious, time-consuming, and costly orthodox triangulation through jungle, desert, wilderness, and snow. Extrapolating the accomplishments of the last 300 years, he knows that conventional triangulation is really a *long* long-range program and that, unless corrective measures are adopted, he will finish with a scrambled jigsaw puzzle of datums, and that the unscrambling of these will be prohibitive in cost, not to mention the ensuing confusion. So he hesitates, wipes his brow, then plods on in the same rut, dreaming about the grandeurs of the golden future.

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Town Planning Course Offered at Toronto

THE UNIVERSITY OF TORONTO has started a town planning course in conjunction with the Canadian Government's Central Mortgage & Housing Corporation and the Ontario Government's Department of Planning and Development. The course will not lead to a degree but is offered to graduate students working toward master's degrees.

Students in engineering, architecture, and social work are expected to attend the lectures and discussions. Miss Jacqueline Tyrwhitt, formerly director of the London School of Planning and a visiting professor at Yale last year, will join the University of Toronto staff as a visiting professor. Lectures will include civil engineering, architecture, geography, social work, and political economy. Each student will spend a summer on field work, and a research project on Ontario town planning problems is to be completed by the class.—*Engineering News-Record*, November 8, 1951.

What's a Map Worth?

By LEO J. ZUBER

METROPOLITAN PLANNING COMMISSION, ATLANTA, GA.

WHAT IS a map worth? Is it worth what it costs to make? The real value of a map cannot be gauged by what it costs but rather by the service it renders. In a very real sense, sometimes maps do not cost anything; they pay for themselves.

The Metropolitan Planning District of Atlanta, which includes Fulton and DeKalb counties, is not now covered by modern, accurate topographic maps. Such maps could be made of the entire area for a local contribution of about 19 cents an acre, or about $125 a square mile. The cost is relatively insignificant compared with the value—a repeating and continuing factor—of the services which such maps perform. Their worth actually defies estimation.

There are many instances in which topographic maps make a difference, a big difference. One community gets a new industry, but another isn't even considered as a possible location. A right-of-way is chosen for a highway or railroad, and engineers know that they have chosen wisely, correctly, and in a minimum amount of time. "Lost land" is placed on the tax books. Hitherto unrecognized natural resources become available. Any one of these services can more than offset the original cost of a topographic map.

INDUSTRIAL SITES

In one instance, a river which runs parallel to a railroad for many miles and which contains an excellent supply of unused water was called to the attention of potential industries. Inquiries were received from at least two important chemical firms which were interested in locating plants in the area because of the excellent supply of water. In both cases, had a development taken place, the initial investment would have been around $5,000,000. In both cases, however, final consideration boiled down to the question of satisfactory plant sites. Inquiries were made as to the availability of topographic maps on which selection of the most advantageous location for the plant, planning of the necessary housing facilities, and location and construction of new roads and similar developments could be readily visualized and appraised. When the interested firms learned that no topographic maps of the area were available, the matter was dropped. The industries indicated that they could not afford to spend the time involved in making the detailed topographic surveys necessary to select satisfactory plant sites, particularly in view of the fact that other areas, for which adequate maps were available, were also being considered.[1]

In 1942 the U. S. Army was looking for a midcontinental location for a $30,000,000 chemical warfare munitions plant. It had to be built on fairly level terrain, close to railroads and to a source of pure water. In addition, it had to be near enough to a populous area to obtain labor, but far enough away to provide safety.

Several states and communities were asked for information concerning possible plant locations. In some places, long-range surveys were begun, but the Denver, Colo., Chamber of Commerce merely laid out the four sheets of large-scale topographic maps which cover the city and its adjacent area. A suitable vacant site between two railroads was found within 10 miles of the city. A water analysis was made, and this, together with all other pertinent information, was sketched on the maps and sent with a brief letter to Washington. When the

Army Engineers received this material, there was no need to make a trip. They could see all they were looking for on a map laid out in Washington. This was industrial location with a "new look"; and, by the method of the old Chinese saying that "one picture is worth ten thousand words," they were sold. In a matter of hours, Denver had a $30,000,000 industry.[2]

It is extremely difficult to appraise the high value of topographic maps in industrial development. Probably, however, the advantages of these maps in the realization of industrial development alone is sufficient to justify modern statewide topographic coverage. Engineers have estimated that as much as 70 percent can be saved on preliminary surveys for the selection of industrial sites if topographic maps are available, not to mention the advantages of a properly chosen site once the industry is established.

Those interested in the development of greater industrial wealth in a city, county, or state will be particularly impressed with one specific example of the need for adequate topographic maps. A promising district in one of the Southern States lost $10,000,000 in new industries because topographic maps for planning purposes were not available to the prospective manufacturers. This is only one of many similar instances. Confronted with the selection of one of several plant sites of generally equal desirability, industrial planners are certain to give more attention to the site on which they can visualize their plant layout. This would be the area covered by a topographic map. A State alert to increasing its industrial wealth must anticipate the continuing demand for more and better topographic maps.[3]

Again, the need for reliable and accurate maps in site survey work is emphasized by W. P. Dermott, industrial agent of the Louisville and Nashville Railroad. In a letter to the director of the Atlanta Metropolitan Planning Commission, he cites the following instances in which the existence of adequate topographic maps played a significant role in determining the location of industrial plants.

(*a*) *Louisville Medical Depot.*—This 575-acre area had to be located near a large town and transportation center above flood state, where a large proportion of the land was at zero grades because large warehouses and rail facilities were required. Topographic maps of the U. S. Geological Survey expedited our work in this respect and enabled us to ascertain readily where a suitable site was available.

(*b*) *Bluegrass Ordnance Depot.*—Near Richmond, Ky., a survey was made in cooperation with the Federal Government to locate an area of about 15,000 acres with certain specific land characteristics for the site of the installation which later became the Bluegrass Ordnance Depot. Only through the existence of topographic maps were we able to establish a suitable area within a short period of time and thus place Kentucky in a competitive position with other sections of the country for the final selection of a location for the installation.

(*c*) *Atmospheric Nitrogen Plant.*—When surveys for the atmospheric nitrogen plant near Henderson, Ky., were in progress, wide use was made of available topographic maps of the areas along the Ohio River. Although this facility was finally located west of Henderson on the Illinois Central Railroad, we know that adequate contour map data were very helpful in the survey work which finally resulted in securing for Kentucky this valuable addition to its industries.

(*d*) *U. S. Naval Ordnance Plant.*—When surveys were in progress to locate a site for the Naval ordnance plant and proving ground later constructed at Louisville, the existence of adequate map material assisted immeasurably in enabling us to handle such investigations promptly so that we were in a much better competitive position than would otherwise have been possible.

In sections of our territory not covered by topographic maps, Mr. Dermott states, we find it very difficult to make preliminary selections of industrial areas.

When maps are lacking, extra ground work is required to find suitable sites; and, if the area is in the vicinity of large creeks or rivers, the possibility of flooding is always present. Unless we know the elevation of the property so that it can be checked with flood records, any history of flood water over the area must be obtained from local citizens.

"We have found that industry is not satisfied with 'hearsay' and will confine considerations to areas for which specific information is available. I think it is definitely true that these areas have a decided advantage over those that are insufficiently mapped."[4]

In another instance, the Winston Salem industrial area in North Carolina lost $10,000,000 worth of new industries when it could not provide contour maps to give prospective manufacturers the facts about new sites they were considering.

According to a recent article published in *Nation's Business,* engineers figure that topographic maps save 70 percent on preliminary surveys and usually guarantee a big saving in terms of proper choice of sites. On an industry-wide basis, this has been translated into an estimated annual saving of $150,000,000.[5]

RIGHTS-OF-WAY

The value of adequate maps was recently demonstrated in connection with the construction of a highway between two points 16 miles apart. Three location surveys were made at an approximate expenditure of $5,000, and the cost of the proposed highway was estimated from these surveys in the usual manner. Before the highway was constructed, the State geologist appealed to the governor to have a topographic map made of an area several miles wide along the route of the proposed highway. This map was compiled at a cost of $2,200, and from it a new route was selected. The cost of the highway constructed on the new route was $200,000 less than that estimated for the route selected before the topographic map was made.[1]

In reference to the design of the Detroit Crosstown Motorway, H. C. Bacon, planning engineer, Michigan State Highway Department, stated, "It is estimated that the cost of the U. S. Geological Survey maps will be saved many times over by the reductions in right-of-way costs."

Likewise, Gen. Richard K. Hale, director, Massachusetts State Highway Department, stated that the savings effected in the highway department alone could have paid the entire cost of the topographic surveys of Massachusetts.

The location of highways requires careful reconnaissance of the terrain and the major control points. The topographic map serves as a guide to the location engineer and enables him to determine the most feasible and economical route. Without accurate topographic maps, a reconnaissance survey on the ground does not, in a majority of cases, enable the engineer to make the most practical and economical selection. The very fact that topographic maps offer this advantage will in the long run save the State a large amount in the selection of the proper location. In addition to this saving, a considerable amount of "on the spot" field reconnaissance work is eliminated with a corresponding decrease in funds expended for salaries and expenses.[2]

In one prewar year, $500,000,000 was spent for the construction of highways in the United States, according to Robert Stephenson of the Pennsylvania Topographic and Geologic Survey. Highway engineers estimate that $97,500,000 could have been saved in preliminary surveys and construction costs had topographic map coverage been adequate. In this case, the lack of topographic maps may be directly translated into a loss in tax money.[3]

The chief engineer of one railroad saved $85,000 by changing the route of a rail line after examining a topographic map. This sum is a mere pittance when compared with the estimated $100,000,000 the railroads of the United States would have saved in preliminary surveys alone had topographic maps been available. No doubt the saving in construction costs would have reached an almost astronomic figure. Civil engineers have estimated that $28,000,000 per year in operating expenses could have been saved had the curves and grades been reduced. Topographic maps, had they been available, would have contributed greatly to effecting this tremendous annual saving. The estimated saving in operating costs for 1 year alone could pay for the topographic mapping of an area almost four times that of the Commonwealth of Pennsylvania.[3]

Federal and State highway officials need contour maps in order to select the shortest and most level routes, plot bridge sites, and plan drainage. In 1938 U. S. highway construction cost $500,000,000. The expenditure for surveys alone totaled almost $50,000,000. Highway engineers estimate that preliminary contour map coverage would have saved approximately $37,500,000 on surveys and cut construction costs $60,000,000.[5]

TAXABLE PROPERTY

It is known that the area of Kentucky is approximately 26,000,000 acres, but somewhere within this vast region about 1,200,000 acres are unaccounted for. The practice of writing deeds to cover so much area "more or less," or "from a stone's throw from the old oak tree" is responsible for this 5 percent discrepancy. Most taxpayers make a conscientious effort to report the correct amount of property for tax purposes, but many can and do hide the true value of their property behind the lack of common knowledge of lands in general and thus escape their fair share of the cost of government. This situation can be remedied only by, first, accurate maps on which to plot and locate property; second, maps which will permit the proper recording of geological and engineering data necessary for intelligent appraisal; and, third, adequate training and supervision in the use of such tools.[2]

NATURAL RESOURCES

In one northeastern State it has been estimated that an adequate mapping program could be established and maintained at a cost of only fifteen-thousandths of 1 percent of the value created by the mineral, forest, and agricultural industries each year. Such an expenditure is insignificant in comparison with the benefits which could be gained through such a program.

In California existing topographic maps alone have saved the Division of Water Resources more than $2,250,000, according to Edward Hyatt, State engineer.

Similarly, the Metropolitan Water District of Southern California could have saved $750,000 if inch-to-the-mile contour maps of the southeastern part of the State had been available, according to Julian Hinds, assistant chief engineer of the District.

A. H. Markwart, vice president, claims that "adequate maps of the Pit, Feather, Bear, and Stanislaus Rivers would have saved the Pacific Gas and Electric Company $200,000."[2]

Likewise, good contour maps saved New York City hundreds of thousands of dollars when it ran aqueducts to the Catskill Mountains to increase its water supply.[5]

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New Lightweight Tripod Facilitates Combat Surveys

IMPROVED ACCURACY of field artillery fire is now possible through the use of a lightweight tripod recently tested at Ft. Belvoir's Engineer Research and Development Laboratories.

The tripod enables combat survey parties to place and plumb ranging poles rapidly, and then take cover while observations are made. Because of the speed and simplicity of handling, the tripod is also suitable for Arctic survey operations.

Constructed principally of aluminum, the tripod weighs only 4¼ pounds and is 42 inches long. A star-shaped head holds the three legs together. The legs have foot pieces of stainless steel points shaped to provide an angular spur when the legs are placed at normal slope. The sliding plumb bar attached to the tripod head pivots around the tripod bolt. The plumb bar is held rigidly in the desired position by the tripod bolt and is designed to provide radial and lateral movement for plumbing the ranging pole over the desired point.

Rigorous field tests undertaken by ERDL engineers have proved that the tripod can withstand winds up to 40 miles per hour without appreciable loss of accuracy for pointings on the ranging pole. In addition, it is sufficiently sturdy to withstand air drop delivery and handling under field conditions. The average time for setting up the tripod and ranging pole is less than 1 minute.

The tripod is now being given final evaluation tests by Army Field Forces service test agencies before being standardized by the Corps of Engineers.—Release from the Engineer Research and Development Laboratories, Ft. Belvoir, Va.

Coordinates in Title Description

By WM. C. WATTLES, L. S. 1071, CALIF.

INCLUSION of coordinate values in descriptions of land boundaries, for the purpose of further identification of points and monuments, is a comparatively new procedure. It is important that caution be observed in the introduction of any variant to long-established practise, especially when the change or supplementation affects legal method or interpretation. The possibility of conflict arising from the addition of calls or ties beyond those ordinarily used cannot be overlooked. The discussion here attempts to present considerations, examples, and conclusions toward the end that there may be developed a reasonably uniform system of description writing, using coordinate values in addition to ordinary recitals, which will be comprehensive, accurate for survey practise, conformable with title, and not violate long-established principles of land conveyance through description.

The mechanical and technical procedures involved or required in obtaining coordinate values, or conversions to ground measurements, are not within the scope of this discussion and have not been considered; it is presumed that the reader has the knowledge, or access to the available data, to perform the necessary mechanical procedure.

The aim is to present a workable and satisfactory scheme combining the requirements of title with the data necessary to conformable ground location.

CONSIDERATIONS

A description is the written record of a physical area or boundary, for the purpose of perpetuating location and title.

A description to be definitive must recite legal or physical monuments defining boundary, or associated therewith, and properly related to one another by dimensions which can be developed from survey or record or other reference.

A description, to be useful and fully operative, must carry sufficient recitals other than, or in addition to, dimensions and statement of monuments, which will specifically determine the interest of the parties named in the document, and indicate the integrity of the land boundaries as related to claims or title of adjoiners.

It is a general rule that any description is good and valid which identifies and distinguishes a specific parcel of land from all others, but such rule may be modified or limited by legislative act for purposes of recordation and legal notice.

The lines and angles of boundary should be sufficiently described by dimension, reference ties, and record reference, to enable an accurate relocation in physical position, if and when the original monuments are disturbed or destroyed, or if the original angle positions had no physical existence other than recitals in the description.

For transfer of title, based on record data, a valid and competent description can be written without dimension, the location and boundaries being fixed wholly by ties and references to points and lines already established in earlier records; or a combination of record references and supplemental dimensions may be used. If the parcel to be described contains or adjoins no record boundaries or corners the description must be wholly dimensional, but with at least one tie to a record reference point, for location and identification.

It is possible, and frequently occurs, that a parcel of land is described, and transferred by recorded deed, one or more times before any ground location is surveyed or monuments set. Under such circumstances there can be no recital or description of monuments, and the given dimensions control over any subsequent monument positions unless there is a legal adjustment to the contrary.

Every description in which statements

of distances and bearings are used should recite the unit of measurement (feet, chains, etc.), and the basis of bearings (a line of record, true meridian through a specified point, grid meridian, etc.). The unit of measurement is usually given with each statement of quantity (75 feet, 23.44 chains). The basis of bearings may be stated, or implied by recital of the record bearing and call along a record line, or by use of record bearings shown on the subdivision within which the described property lies. The specific statement of the basis of bearings is especially advisable if any of the bearings in the description are given as "North," "due North," "East," "due East," etc., since there is a possibility of misconstruction and assumption that such calls are applicable to geodetic meridian instead of planimetric development thereof.

Although use of azimuth, instead of bearing, is valid for description purposes, it is not recommended for general use; common and long time practise of bearing recital has made such form more readily understood and acceptable, except in certain technical situations. Inasmuch as azimuth may be reckoned from either north or south, the need of statement of origin is evident in any description using it. Azimuth generally is based on true meridian through the initial point of each line recited, thus causing a variation between azimuth angles and measured angles between lines. The recital that azimuths are given as angular relations from a single stated meridian is necessary in any description involving the usual planimetric system.

The most accurate and satisfactory method of survey relocation of monument position is that of rectangular plane coordinates developed from the triangulation control stations established by the U. S. Coast and Geodetic Survey, segregated for practical use into the various State Coordinate Systems.

Any monument position may be located and given its correct rectangular plane coordinate values in the applicable State Coordinate System. Such values, however, are inoperative by themselves for record relocation unless defined or recited in an existing record. If a description or map of an original location, or of a properly determined relocation, defines the monument or its position, and gives also the coordinates thereof, such description or map is competent to serve as a base for subsequent location from the coordinates.

Inasmuch as the coordinate method is devised and used primarily as a means of precise survey procedures, its adaptation to title matters must necessarily be limited to a subordination in favor of other requirements of title and record location. In any combination of statements including recitals both of coordinate values and record calls, if a conflict appears, the record will prevail over the coordinate position, in interpretation; but the contrary may be shown.

The distance and azimuth, or bearing, between two coordinated points, as computed from the coordinates of such points, are correct only as grid dimensions; the actual length between the two points on the ground, and the bearing (unless said bearing is referenced on the grid meridian) of the line between such points will differ from the grid dimensions; therefore in a description, any recital of coordinates for a point or monument must be specific as to its value and relationship with the true ground and title position and values of the point. The grid dimension will correspond to the ground dimension only when a balance or compensation exists between the elevation and scale factors used in transforming actual ground measurement to grid dimension.

Any point or ground position, monumented or not, can be placed by its coordinates, and replaced with precision by proper survey procedures. It does not follow, however, that such a point is a correct title and record position. The surveyor who fixes the coordinates of a certain monument, claimed by him to be a corner of title, merely identifies an accurate procedure for relocation of that

monument, but does not determine its title value. There is no criterion of the title accuracy of a point merely because it is given coordinate values. Unless and until the coordinates of a point are established of record, either in description *a priori*, or by court order, as a superior call for a title fix position, the value and weight of coordinate recital is relegated to the same level as that of any other dimension.

Any person, proprietor, or court, interested in land boundary, is concerned with its title certainty and physical position; it is of no moment that the description recites coordinates or grid dimensions; these are merely more or less meaningless (to him) appendages accepted as routine or technical additions to the description toward making it a formal instrument. The surveyor making the ground location of the described coordinated corners is the one who must recognize the value, possess the knowledge, and have the ability to apply coordinate dimensions. If he has the "know how" to add Coordinate System technique to ordinary surveying procedure, a proper location is possible; otherwise he had better leave it alone. Under such circumstances the client is advised to rely on legal interpretation of his title and possession.

A valid and good description may be written by reference, partly or wholly, to a map of record. Proper reference to such a map reads into the description all matters shown on the map which may be pertinent to the location and interpretation of the boundaries of the described parcel; such matters may apply to the relative position and size of the parcel indicated by the plan of the entire subdivision, or even extend to the exterior boundary dimensions and ties thereof.

Maps are a valuable asset in description reference because their capacity for indicating multiple ties, delineation of associated lands, extra dimension and location data, and notes of general character, can prevent the frequent tendency of worded descriptions to become involved or confused. For title and reference purposes it is essential that the map be recorded in a public office, since only such office can lay good claim to the giving of legal notice to the world at large.

EXAMPLES

The following examples and comments will illustrate the use and application of coordinates applied to descriptions usable for title purposes:

Example 1

A parcel of land in Black County, State of *Q*, described as follows: beginning at a 4×4 stake in a mound of rock on the north side of Highway 2, said stake having grid coordinates *X*....., *Y*....., of Zone 5 of the *Q* State Coordinate System; thence northerly to a point in Ash Creek having grid coordinates *X*....., *Y*....., of said Zone 5; thence easterly to a 2-inch pipe marked *MH*, having grid coordinates *X*....., *Y*....., of said Zone 5; thence southerly to a point having grid coordinates *X*....., *Y*....., of said Zone 5; thence westerly to the point of beginning.

Comment—If we accept the definition of specific locatability and identification of position, this is a perfect description, since there is only one possible location of the described land.

The legal restriction in some State laws permitting the use of coordinates only as an addition to record references will render this description legally invalid or voidable.

If the described area has any record title boundaries, the description here fails by nonrecital of such boundaries.

The recital of the State Coordinate System, as here noted, is sufficient to identify the matters related thereto, including the coordinate values and the mathematical procedures necessary to fix the monument positions; also both the grid and actual dimensions. However, technical knowledge is necessary to make such determination, making the description as its stands of little value for purposes of assessment, taxes, or even ground boundary dimensions and associated properties.

Example 2

A parcel of land in Black County, State of *Q*, described as follows: beginning at the southeast corner of the land of Doe as described in deed recorded in Book 27 Page 122 of deeds in the office of the Recorder of said County, said corner being marked by a 4×4 stake in a mound of rock in the north line of Highway 2, said stake having established grid coordinates as recited in said deed to Doe, of *X*——, *Y*——, of Zone 5 of *Q* State Coordinate System; thence along the east line of said land of Doe, N 15° 37′ 22″ W, (bearings based on the grid meridian of said Zone 5), a distance of 473.88 feet to the northeast corner of said land of Doe, a point in Ash Creek, having grid coordinates *X*——, *Y*——, of said Zone 5; thence N 65° 30′ E, 698.70 feet to a 2-inch pipe marked *MH* set for the southwest corner of Lot 4 of Tract *RR*, as per map recorded in Map Book 10 Page 45, Records of said County, the grid coordinates of said pipe being determined in this description as *X*——, *Y*——, of said Zone 5; thence S 10° 28′ 55″ E to the north line of said Highway 2; thence westerly along said Highway to the point of beginning.

Comment—This description is good and sufficient to fill title and location requirements when full use is made of the recitals and ties given.

The coordinate values allow a correct repositioning of the designated corners, if destroyed or lost or unmonumented.

The base of bearings is definitely stated, allowing comparison with bearings from some other base, if both are referred to a common line of description; also allowing check of measured angles against bearing differences.

The coordinates are recited in a manner making them subordinate to title calls or dimensions, if a difference exists.

The location of Highway 2 has to be determined from the deed or map or field notes thereof which are matters of record; the description here permits a flexible connection but a rigid contact.

The given bearing from the coordinated 2-inch pipe to the Highway provides a fixed direction correctly related angularly to the first course of the description.

Example 3

That portion of Lot 6 Tract *MM* in the County of Black, State of *Q*, as per map recorded as filed map No. 435 in the office of the Recorder of said County, described as follows: beginning at the most easterly corner of said Lot; thence northwesterly along the northeast line of said Lot a distance of 378.55 feet; thence westerly in a direct line 843 feet more or less to a 1-inch iron pipe set to mark the northeast corner of land of Roe as described in deed recorded in Book 19 Page 88 of Deeds, Records of said County, said pipe having grid coordinates *X*——, *Y*——, of Zone 5 of *Q* State Coordinate System, said coordinates being determined for said pipe in this description; a 3×3 stake intended to mark the northeast corner of said land of Roe, but discovered to have been removed and erroneously reset lies northerly 1.75 feet, and has grid coordinates *X*——, *Y*——, of said Zone 5; thence southerly along the east line of the land of Roe to the southeast line of said Lot 6; thence northeasterly along said southeast line to the point of beginning.

Comment—This description is complete from a title standpoint, but requires record search by the surveyor to dimension the boundaries.

Examination of the description shows the intent to be principally a fixing of the northerly line of the land in question. The east line is a lot line determinable from the map data, with the east terminus of the north line of property fixed at 378.55 feet along the line from the easterly corner of the lot. The west terminus of the north line is fixed in the description by monument and coordinates, which here are made paramount in event of destruction of the pipe (the intent seems to be to fix the pipe as Roe's true corner as against the disputed location of the 3×3). The west line is the east line of Roe, a good title tie; the south line is a boundary of the Lot.

It is evident that it was considered unnecessary to coordinate any points except as noted; quite possibly the map of Tract *MM* showed coordinates for its corners, or some other specific means of their location was available.

Example 4

The Southeast Quarter of Section 17 T 3 S, R 8 W,—Principal Meridian, in the County

of Black, State of *Q*, the corners of said Quarter being more particularly defined as follows: the SE corner, an original stone in mound, having grid coordinates *X*——, *Y*——, of Zone 2 of *Q* State Coordinate System; the east quarter corner of Section located on line midway between original SE corner and original NE corner of said Section, having grid coordinates *X*——, *Y*——, of said Zone 2; the south quarter corner of said Section, a 2-inch capped pipe set for said corner by the Surveyor of said County, having grid coordinates *X*——, *Y*——, of said Zone 2; the center of said Section, a 4×4 stake in mound of rock, set at intersection of straight lines connecting opposite quarter corners of said Section, having grid coordinates *X*——, *Y*——, of said Zone 2.

Comment—The first sentence of the description is sufficient for any title purpose, and needs no qualification. The addition of described corners and coordinates furnishes a definite means of relocation in the event any or all the monuments are altered or destroyed. The recited coordinates also furnish information as to any inaccuracy of described location for the east quarter corner and the center of Section, if the lines of Section are rerun and show discrepancy. Here, as in other examples, the coordinates are confirmatory only of the correct corner positions, the description of the corner taking precedence of the coordinates as long as the corner may exist.

The above description could also be written as regular metes and bounds, reciting point of beginning, traversing around boundaries, reciting monuments and coordinates, etc., but gaining little, if any, advantage in space or clarity.

Example 5

That portion of Block 14 of the Townsite of *KK* in the City of Green, County of Black, State of *Q*, as per map No. 999, Records of said County, described as follows: beginning at the intersection of the centerlines of Main Street and 10th Street, in said City, a point having grid coordinates *X*——, *Y*——, Zone 4 of *Q* State Coordinate System, said intersection and centerlines and coordinates being established by the City Engineer of said City and shown on Street Map No. 6354 on file in the office of said Engineer; thence westerly along the centerline of Main Street 127.99 feet; thence northeasterly in a direct line to a point in the centerline of 10th Street distant northerly 87.00 feet from the point of beginning; thence southerly along the centerline of 10th Street to the point of beginning; except those portions within the lines of said streets.

Comment—Reference to the City Engineer Map furnishes all the additional information needed, outside the description. It is very effective practise for the City Engineer to establish street centerlines, coordinate the intersections on the State System, make a map showing all data, and file it in his office; recordation is unnecessary. The exception of part in streets effects a description of the part of Block only, and saves extra calls and dimensions required to bound the part in the Block; the surveyor must make the computations in any event, if he is to stake the land.

Example 6

That portion of—(here follow with the ordinary type of description, part lot, or metes and bounds, etc. and then add—). For more particular description and location of the boundaries of the herein described land, reference is made to the map attached to this instrument and made a part thereof.

Comment—The vital part of this example is the reference to map attached—which map must be recorded as a part of the document. On this map can and should be shown the platted boundaries, description of found and set monuments, coordinates of at least two corners, dimensions between all corners and ties, note as to source or base of coordinates, notes or references to any applicable record data of deeds, maps, etc.

An alternate form of the map attached is that of recording, separately and priorly to the instrument containing the description to be identified, a map of the area in question, following the legal procedure required in the district for such recording, and showing on such map all necessary information as above outlined; then the description carries the reference to that map recorded in . . . etc., instead of "map attached."

Example 7

. . . to a 2-inch pipe with tag (L.S. 666), having grid coordinates *X*....., *Y*....., said Zone 3; thence along the east line of said Tract *WW*, N 26° 47′ E (base being grid meridian of said Zone 3) (record bearing of said east line Tract *WW* being N 26° 33′ E) a distance of 487.00 feet to a 6×6 squared stone flush with surface, having coordinates *X*....., *Y*....., said Zone 3; thence S 76° 50′ E, 333.00 feet; thence . . .

Comment—It is often advisable to show relation between different bearings on the same line for title or record comparison. There is no simple phrasing adequate to express the relation, so each case will present its own solution.

The bearing S 76° 50′ E follows the grid base with the proper angle to N 26° 47′ E; the record bearing for east line Tract is informational only.

CONCLUSIONS

Descriptions written for title purposes may, in addition to the usual ties, recitals, and references, give the coordinates of one or more corners or monuments of the described property. The coordinate values are supplemental to the calls in the description and provide a means of accurate physical location of the points determined by title recitals. Coordinate values normally are subordinate to title calls, but may under some circumstances take precedence over other recitals.

Reference to coordinates must be definite, specifying the type (grid), the Zone (if there be such), and the Coordinate System of reference; the Coordinate System, if established by legislative act, is sufficiently identified by naming the System as such; if it is not a legalized system, more particular statement or reference must be made for identification.

"Grid" coordinates are preferred, as they are uniform in derivation in any particular System, and from them the surveyor may readily develop actual ground dimensions for any elevation or position in the Zone.

Base of bearings from an adjoining record bearing is usually most convenient and acceptable in title, but any other is usable if sufficiently identified; grid meridian base, if used, should be compared or related in the description with the record bearing on some described line.

It is better, where possible, to incorporate recital of grid coordinates in the body of the description, rather than place it at the beginning or end, the reason being that careless or intentional deletion of recital is more difficult.

If the description is complete as to dimensions, and is mathematically correct in closure, one coordinated point is sufficient to position property, but two points at some distance apart are better for check. It is rare that all points need their coordinates given.

If the description is incomplete as to dimensions, those omitted being covered by title references, then it may be advisable to give coordinates of all undimensioned positions.

No coordinates can be given for a point *A* unless there has been an actual connecting survey therefrom to a known coordinated point *B*, or unless it is possible accurately to compute position of point *A* from a record coordinated point *C*.

Because of the precision requirement of coordinates, none should be stated in a description until verified by double original check of the surveyor and an independent person such as County Surveyor or City Engineer.

The examples given above are not intended to set a rigid form of description but to indicate the variables and possibles of incorporating reference of coordinates into description; any form is acceptable which will show the clear relation between the items to be considered, the intent of the parties, the maintenance of title, the mathematical accuracy of dimension between points and positions, and other matters necessary for proper interpretation.

The Microptic Alidade

By D. R. STANLEY

DIRECTOR, HILGER AND WATTS, LTD., LONDON, ENGLAND

SHORTLY AFTER WORLD WAR II, Hilger and Watts, Ltd., of London, England, were visited by Dr. H. V. Warren of the University of British Columbia, who asked us to develop a new alidade, according to his specifications, which would be an improvement on the heavy, clumsy, and readily damaged alidades of current manufacture.

The new instrument was to be lightweight, streamlined, and portable. It needed to be tucked under the arm when on horseback, thus leaving both hands free to the rider. The exposed silver arc, vernier, and Beaman are were to be enclosed and the graduations placed on glass scales.

A wooden model secured Dr. Warren's order for a prototype alidade which was subsequently thoroughly tested in British Columbia. So successful were the performance tests that the company decided to adopt this design for standard manufacture. It was this alidade which was exhibited at the 1949 meeting of the American Congress on Surveying and Mapping and which created so much interest because of its easily read glass scales, light weight, and, most important of all, the fact that the alidade could be carried on the arm and yet leave the hands free.

The alidade consists of three principal units:

1. The blade
2. The vertical pillar, axis, and circle
3. The telescope and circle-reading microscope

1. *The Blade*

The 15-inch blade is constructed from duralumin, its underneath surface being machined to provide a bearing strip at each side 0.3-inch wide. It is anodized and stove-enamelled white underneath and green on the top and sides. Attached to the blade by two equal pivoted arms is the parallel rule which is constructed from hard brass. A circular bubble is mounted on the blade and, when required, a 4-inch trough compass.

2. *Vertical Pillar, Axis, and Circle*

The pillar is in two parts, the upper part being hinged to the lower. A milled head adjustment screw, which projects through an aperture at the base of the pillar, permits the horizontal telescope axis to be made level. A cross bubble is provided on the top of the pillar.

The axis bearing is formed at the top of the pillar, the axis bearing being retained by a cap held by four screws. On the left of the axis is a fitting for the telescope clamp, the arm of which projects into a swelling on the pillar into which is mounted the telescope tangent screw and the spring box.

On the right hand end of the telescope axis is the circle bearing to which is screwed the altitude bubble casting, an arm from which projects downwards inside the vertical pillar. This arm is held between a spring box and the altitude bubble adjustment screw.

3. *The Telescope and Circle-Reading Microscope*

The 15-power telescope, with an aperture of 31 mm., is held to the axis by a boss which passes through the centre of the axis. The circle-reading microscope is mounted on the top and a ground glass window allows the entry of light to illuminate the vertical scales.

The vertical scale, observed by the circle-reading eyepiece, is engraved on a

Presented at Eleventh Annual Meeting, American Congress on Surveying and Mapping, Washington, D. C., June 18–20, 1951.

2-inch diameter glass annulus with degree divisions subdivided into 10 minutes, embracing 45° elevation and depression for both forward and backward sights. It is also engraved with the Beaman stadia arc which consists of two scales graduated so that the observer can reduce rapidly the stadia reading to (1) the difference in elevation between the instrument and staff, and (2) the true horizontal distance of the staff.

The divisions on the V-scale are proportionate to sin $E \cdot \cos E$, where E is the angle of elevation. The scale is engraved at suitable positions in terms of $100 \cdot \sin E \cdot \cos E$ so that whole numbers are obtained from 1 to 40. The horizontal scale is graduated with suitable divisions proportionate to $100\ (1 - \cos^2 D)$ and therefore provides the correction factor for horizontal distances.

Three apertures are provided in the field of view of the circle-reading microscope. In the upper one appears the degree scale, in the centre the vertical Beaman arc, and in the lower the horizontal Beaman arc. Each scale is read against a single index line.

The weight of the instrument is only 4½ pounds, and it is packed in a mahogany case with carrying strap. We have been experimenting with a canvas or leather holster type of carrying case.

After severely testing a purchased microptic alidade, the U. S. Geological Survey requested modifications which are incorporated in the prototype on display at the 1951 meeting of the American Congress on Surveying and Mapping. The main differences between this and the standard model are as follows:

1. Omission of parallel rule
2. Omission of provision for cross-leveling
3. Increase of 1-inch in length of blade
4. Slight increase in height of pillar
5. Bubble on telescope
6. Special reticule

Field tests have demonstrated the satisfactory performance of both models, a tribute to the sound ideas advanced by Dr. Warren and the topographers of the U. S. Geological Survey and to the experience and skill of the designers and instrument makers.

* * *

American Society of Photogrammetry Holds Eighteenth Annual Meeting

The Centennial of Aerial Photography was the theme for the Eighteenth Annual Meeting of the American Society of Photogrammetry which was held at the Hotel Shoreham, Washington, D. C., on January 9, 10, and 11, 1952. The three-day sessions were attended by more than 1,000 members and guests from the United States, Europe, and Latin America. The panel on "Photographic Interpretation," for which Arthur C. Lundahl was moderator, was one of the best attended and brought out many of the varied uses and techniques developed for civilian and military applications as well as some of the problems still to be solved. Other panels were held on "An Accelerated Surveying and Mapping Program" and on "Improving Aerial Mapping Photography."

George D. Whitmore, Chief of the Technical Staff, Topographic Division, United States Geological Survey, was elected president of the Society for 1952. The Society will be host to and take an active part in the Seventh International Congress and Exposition of Photogrammetry of the International Society of Photogrammetry which will be held in Washington, D. C., September 4–13, 1952.

—Alfred C. Stiefel

Surveying Refresher Courses in Virginia

By S. W. DOBYNS

DEPARTMENT OF CIVIL ENGINEERING, VIRGINIA MILITARY INSTITUTE

THE Department of Civil Engineering at Virginia Military Institute has conducted two short Surveying Refresher Courses in Virginia under the sponsorship of the Virginia Association of Surveyors, Inc. and the Virginia Department of Highways, with the assistance of the Division of Trade and Industrial Education of the State Board of Education. Nearly 100 surveyors attended the first 5-day course, held in January 1950, which was also sponsored by the Virginia Electric Power Company, the Appalachian Electric Power Company, the City of Richmond, the U. S. Bureau of Public Roads, the U. S. Army Topographical School, Fort Belvoir, Virginia, and the League of Virginia Municipalities. The second surveyors' school was conducted at VMI in January 1951, and attendance was limited to 50 surveyors from the Department of Highways, the Association of Surveyors, and Virginia municipalities, to allow division of the group into three small sections for the purpose of concentrating on problem work in the theory of curves and photogrammetry. No special educational qualifications were required of the trainees, although the program of instruction was designed for land surveyors and highway surveyors of considerable experience who desired training in calculating surveying problems and sought advancement of their profession by the consideration of the ethical and legal aspects of surveying.

The content of the first course was determined from requests of surveyors throughout Virginia and included the following subjects: care and cleaning of equipment; transit adjustments; computations and use of tables; determination of true meridian by solar observation; determination of magnetic declination; and computation of latitudes and departures, double meridian distances, coordinates, and areas.

Various authorities in their respective fields addressed the trainees on the following subjects: Plotting of Data, Reasonable Standards of Accuracy, Errors and Omissions in Land Surveys, Virginia Coordinate System, and Sources of Information. There were two panel discussions, with three authorities in the subject on each panel, on the following subjects: Legal Aspects of Surveying, and Registration of Surveyors. E. Lawrence Chandler, Assistant Secretary of the American Society of Civil Engineers, delivered the final address on Professional Ethics at the graduation exercises. "Membership in the engineering profession is a privilege, and that privilege brings responsibility to the public," Mr. Chandler said, and "the measure of our stature will be found in the degree to which we fulfill our responsibilities."

The refresher course of the second surveyors' school included 15 hours of the theory of curves and 11 hours of photogrammetry, with an additional 12 hours devoted to conferences, lectures, and motion pictures. Maj. W. B. Wilson and Capt. R. E. Anderson of the Department of Civil Engineering at VMI presented problems in vertical and horizontal curves, super-elevation, compound curves, simple spirals, double equal spirals, and circular curves with equal spirals. The author presented a basic course in photogrammetry, which included:

I. An introduction to photogrammetry

II. A study of a photographic mission, including the aerial cameras, determination of height to be flown, the scale of the photography, time interval, and overlap

III. Photo-interpretation and stereo-vision, with laboratory practice in orientation of photographs and delineation of details of

Presented at the Eleventh Annual Meeting, American Congress on Surveying and Mapping, Washington, D. C., June 18–20, 1951.

topography, emphasizing land forms and land use

IV. The use of the stereocomparagraph and height finder in the laboratory to determine differences in elevation and grades and alignment for route location

V. The construction of mosaics and map compilation using radial-line plots, metal-arm templates, sketch-masters, and stereocomparagraphs.

G. Brooks Earnest, Dean of Engineering at Fenn College, Cleveland, Ohio, delivered an inspiring address on "Reasonable Standards of Accuracy." Dean Earnest, who is a Director of the American Society of Civil Engineers, and a member of the American Congress on Surveying and Mapping and of the American Society of Photogrammetry, presented a convincing case for the use of adequate control and justifiable precision in both land and highway surveying, and called on the surveyors to meet their responsibilities to the community and State, thereby raising their status to the position of respect that is due them as members of a major profession in the field of civil engineering.

Officials of the Division of Location and Design of the Highway Department met with their party chiefs during the Session and Brig. Gen. H. B. Holmes, Planning Engineer of the Division of Planning and Economic Development of the Virginia Department of Conservation and Development, addressed the private surveyors and the municipal representatives at the school on the Virginia Coordinate System.

Each surveyor completing the two refresher courses was awarded a certificate for the Surveying Refresher Course and for Advanced Surveying by the Division of Trade and Industrial Education of the State Board of Education.

An exhibit room increased the practical value of both refresher courses in surveying. Exhibitors at the first surveyors' school included the American Congress on Surveying and Mapping and the American Society of Photogrammetry, Norbert Dienstfrey, agent for Fennel-Kassel Instruments, W. & L. E. Gurley, Keuffel and Esser, Harrison C. Ryker, Fairchild Camera and Instrument Corporation, and Bausch and Lomb Optical Company.

J. K. Bailey, Assistant Engineer of the Atlantic Region, represented the Geological Survey of the U. S. Department of Interior at the second surveyors' school with a valuable exhibit of the maps produced by the Survey, and he made many valuable contributions to the courses given at the school. C. V. Draper, U. S. Bureau of Public Roads, presented an exhibit of the use of aerial photographs for reconnaissance and location of the 2,500-mile Mississippi River Parkway as described by William T. Pryor, Highway Engineer, at the seventeenth annual meeting of the American Society of Photogrammetry. Other exhibits included the radial-arm slotted-template construction of a contour map from the Aero Service Corporation, a final print of the map, with test profiles from the Department of Highways, Vinylite plastic relief maps of topographic quadrangles from the Department of Geology at VMI, a plastic relief map of the United States from the Department of Civil Engineering, nine-lens photographs from the Coast and Geodetic Survey, display panels on the status of the surveyor and the use of photogrammetry from Prof. Arthur J. McNair of Cornell University, and descriptive literature from the Aeronautical Chart Service, The Bureau of Standards, the Hydrographic Office, the American Congress on Surveying and Mapping, the American Society of Photogrammetry, and surveying equipment manufacturers.

Motion pictures shown during both schools included "Mapping With Photogrammetric Methods" and "Reconnaissance Mapping with Tri-Metrogon Photography" from the U. S. Geological Survey, "Cartographic Activities in the United States" and "Hydrographic Surveying Aboard the *Explorer*" from the Coast and Geodetic Survey, "Hydrographic Surveying Operations of the U. S. Navy" from the Hydrographic Office,

"The Manufacture and Use of Modern Surveying Instruments" from the Henry Wild Surveying Instruments Supply Co., "Photogrammetric Mapping" from the Fairchild Camera and Instrument Corporation, and "Functional Photography" from the Eastman Kodak Company.

The Virginia Association of Surveyors held their annual meeting at VMI at this time and were urged by their retiring president, S. W. Miller, Jr., of Norfolk, a member of ACSM, to stimulate local chapter work in the association and to affiliate the association with ACSM as a State Section. Mr. Ben S. Clark, who was the first secretary of the Association, was elected president.

In 1947 Col. R. A. Marr, Jr., Head of the Department of Civil Engineering, invited the surveyors of Virginia to meet with him at the Virginia Highway Conference held annually at VMI by the Virginia Department of Highways and the Department of Civil Engineering, and there was born the Association of Surveyors, with John Foster, a member of ACSM, as president for the first 2 years. At their annual meeting during the Highway Conference of 1949 Colonel Marr offered them the use of the facilities and staff of the Department of Civil Engineering for refresher work in surveying, and the association voted to sponsor the first refresher course in surveying in Virginia. The Virginia Department of Highways was invited to co-sponsor the surveyors' school and to send as many members of its survey parties as practicable, and the invitation was accepted by Gen. James A. Anderson, Commissioner of Highways.

Through the cooperation of the Division of Trade and Industrial Education, and by holding expenses to a minimum, the surveyors were charged a registration fee of only $6.00. Meals were made available in the VMI Mess Hall with the cadets, at $0.65 per meal, and bunks were furnished by the VMI Athletic Association at $0.25 a night, so that total expense for the five days, excluding travel, was only $17.00.

The school was scheduled in January to prevent the surveyors from losing too much work, and to coincide with the examination period at VMI so the instructors would have no conflicting schedules; laboratory and field equipment would also be available at this time, and Athletic Association quarters would be unused.

Virginia does not claim originality in these surveyors' schools; we have benefited from the experience of Georgia Institute of Technology and North Carolina State University, both of which have conducted courses for the surveyors of their States. Nor is this the only approach to the solution of the problems in surveying. Talbert Abrams, President of the American Society of Photogrammetry, has sponsored courses in that subject at several universities. The Highway Departments in several States have instituted training programs for their engineers and surveyors. The work of the Education Committee of ACSM, together with Committee 8 of the American Society of Engineering Education that Professor Rice has discussed today and the college training that Professor Egner proposes are examples of the great contribution that ACSM is making through its committees, meetings, and publications.

The credit for any success that these refresher courses in Virginia may have had must be given to the wholehearted cooperation of the sponsors. The report of ACSM on the first surveyors' school stimulated a response on the part of those interested in advancing the profession. There is a need for this program throughout the United States, but growth and development are slow. Through training and education we can develop pride in our work and advance the profession of surveying.

❦ ❦ ❦

The Bureau of Reclamation recently released two new project maps of Cachuma Project, Calif., and Sun River Project, Mont. These maps are in color and measure 10½ by 17 inches. The Cachuma map is also available in 21- by 34-inch size. The maps can be obtained from the nearest regional director of the Bureau of Reclamation.—*Reclamation Era*, October 1951.

Simple Method of Constructing the Oblique Stereographic Projection

By JAMES A. BARNES
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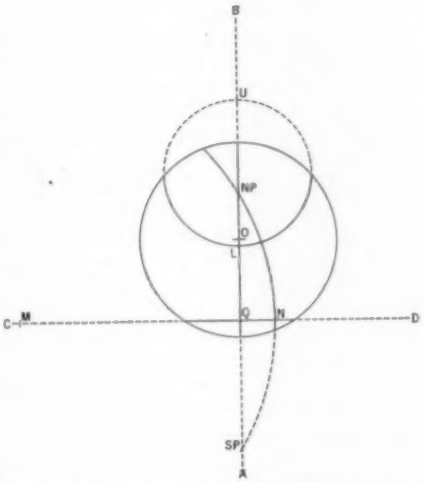
IN recent years we have witnessed an increasing use of maps drawn on oblique phases of the azimuthal projections; the stereographic, equidistant, equal-area, orthographic, and gnomonic. As the point of central interest on the globe varies, it is advantageous to vary the center of the projection used as a base.

Most students of cartography are familiar with the geometric method of constructing the oblique stereographic projection, and also are aware that the other oblique azimuthal projections can be produced by transformation of the stereographic.[1] However, a relatively small number have used trigonometrically derived tables for the construction of the stereographic, and only a few realize the ease with which one can calculate these tables. In view of the simple calculations involved, the scarcity of prepared tables of this type[2] presents no serious handicap, especially as it may be desirable to select a center point or grid interval in terms of degrees, minutes, or even seconds.

One of the principal advantages of the oblique stereographic is the ease and accuracy with which it can be constructed. Inasmuch as all circles on the globe remain circles on the projection, all parallels and meridians will appear as ares on the projection. The straight lines which do result—all meridians in the polar case, the central meridian, and the homolatitude[3] of the center point—are all ares of circles whose centers are at infinity.[4] Construction from calculated tables in addition to saving time and avoiding a maze of construction lines eliminates errors that occur in projecting construction lines and measuring angles with protractor.

In constructing the oblique stereographic from tables first draw a vertical line (*AB* in the figure) through the center



Construction of a parallel and meridian on an oblique sterographic projection centered at 40° N. The parallel shown is 30° N. and the meridian 30° E. of the central meridian.

[1] RAISZ, ERWIN: *General Cartography.* Second Edition, New York. 1948. Pp. 84–85, 88–89.

STEERS, J. A.: *An Introduction to the Study of Map Projections.* Seventh Edition, London. 1949. Pp. 53–56, 80–86.

[2] RAISZ, ERWIN; PEET, OLMSTEAD; and TAYLOR, HORACE: *Tables for Construction of Oblique Stereographic Hemispheres.* Cambridge, Mass. 1942.

[3] For use in this paper, the homolatitude of any point is defined as the same latitude in the opposite hemisphere.

[4] ADAMS, OSCAR S.: *General Theory of Polyconic Projections.* Special Publication No. 57. Department of Commerce, Washington. 1934. Pp. 43–48.

(O) of the projection. This vertical line represents the central meridian. The upper and lower intersections of each parallel are calculated and measured on this central meridian. Intersections above the center are indicated by a positive value and those below by a negative figure. The center of the circle representing a parallel is midway between the intersections (U and L) of the parallel with the central meridian.

The centers of all meridians are on a horizontal line (CD in the figure) which is the homolatitude of the center point of the projection. Obviously, this line crosses the central meridian at a right angle in the hemisphere opposite the center point. To draw the meridians, calculate the point of intersection of each meridian arc with the homolatitude and the position of the center of the arc, and measure them along the homolatitude on opposite sides of the central meridian. The resulting arcs pass through the north and south poles.

The formulas that follow have been simplified by elimination of negative angles, negative latitudes, and angles greater than a right angle. It is assumed that anyone who can read values from trigonometric tables and perform simple arithmetic can calculate tables for the construction of an oblique streographic projection centered at any point on the globe with any grid interval. The scale factor is eliminated by projecting onto a plane tangent to a sphere with a diameter of unity. To determine figures to scale, multiply each calculation by the radius of the size of hemisphere desired in the projection. In the formulas, based on the sphere with the center in the northern hemisphere, the following symbols are used:

α = angle of tilt
ϕ = latitude
λ = longitude
U = upper intersection of parallel with central meridian
L = lower intersection of parallel with central meridian
Q = intersection of homolatitude of center point and central meridian
N = intersection of meridian and homolatitude
M = center of meridian arc on homolatitude

Calculation of the position of parallels:

For north latitudes and equator:
$$U = +\tan \tfrac{1}{2}(180^\circ - \phi - \alpha).$$
For south latitudes less than α:
$$U = +\tan \tfrac{1}{2}(180^\circ + \phi - \alpha).$$
For south latitudes greater than α:
$$U = -\tan \tfrac{1}{2}(\phi + \alpha).$$
For north latitudes greater than α:
$$L = +\tan \tfrac{1}{2}(\phi - \alpha).$$
For north latitudes less than α and equator:
$$L = -\tan \tfrac{1}{2}(\alpha - \phi).$$
For south latitudes less than α:
$$L = -\tan \tfrac{1}{2}(\phi + \alpha).$$
For south latitudes greater than α:
$$L = -\tan \tfrac{1}{2}(180^\circ + \alpha - \phi).$$

Calculation of the position of meridians:

$$Q = -\tan \alpha$$
$$N = \sec \alpha \cdot \tan \tfrac{1}{2}\lambda$$
$$M = \sec \alpha \cdot \cot \lambda.$$

Some may be interested in determining the positions of the centers and the radii of the parallels and meridians from the standard formulas below. P represents the position of the center of the parallel, p the radius of the parallel, M the position of the center of the meridian, and m the radius of the meridian.

$$P = \frac{\cos \alpha}{\sin \alpha + \sin \phi}$$
$$p = \frac{\cos \phi}{\sin \alpha + \sin \phi}$$
$$M = \sec \alpha \cdot \cot \lambda$$
$$m = \sec \alpha \cdot \operatorname{cosec} \lambda.$$

The advantages of centering a projection at any given point are obvious. In addition, the individual will experience satisfaction in making the calculations needed to construct the projection. Also, of more general importance is the fact that an oblique azimuthal projection may well be the only one centered at a particular point of the globe. If this is the case, the resulting map represents a unique and original contribution to cartography.

Some Problems and Techniques in Isopleth Mapping

By J. ROSS MACKAY

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ONE of the cartographic developments that has characterized geographic research in recent decades has been the increasing use of distribution maps. Few studies in regional or economic geography are really complete without quantitative distribution maps to show areal differentiation of elements such as people, land, and crops. In the present discussion an attempt is made to analyze some of the problems and techniques concerning the isopleth map, which is one type of quantitative distribution map.

A number of different words have been used, both in geography and other disciplines, for line symbols which represent various kinds of constant values on quantitative distribution maps.[1] A proposal has recently been made by J. K. Wright that all line symbols be included within the general category of *isograms* with a division into two classes, namely *isopleths* and *isometric* lines.[2] The terminology has certain advantages, because the distinctions between isopleths and isometric lines are of considerable importance: they are based upon different mathematical concepts; require separate cartographic techniques in plotting; and are subject to their own special problems in map interpretation.

Those isograms that pass through *ratios for areas* are isopleths, whereas those through *continuous values for points* are isometric lines. A familiar example of a map utilizing isopleths is the density of population map, while one with isometric lines is the contour map. The preceding terminology is not, however, generally recognized as standard usage. For instance, some authors employ isarithm for what is here defined as an isopleth or isometric line and sometimes it is even used as the equivalent of isogram.[3]

The general inclusive term of isogram means simply "equal-line" but the derivations of isopleth and isometric are suggestive of their differing qualities. Isopleths or "equal-quantity" lines are drawn with reference to data given for statistical divisions such as a township or county. The source data for these lines are obtained mainly by various methods of enumeration and the "quantity" of an isopleth is that of the areal strip through which it passes. For example, we can only comprehend a density of 20 people per square mile for the areas contiguous to the 20 isopleth because density, which denotes number per unit area, must clearly be viewed against an areal background and not along a factitious line. Isometric or "equal-measure" lines are drawn with reference to "measures" at specific points. The source data are obtained principally by measurement, frequently by instrumental means. The "measure" of an isometric line contrasts strikingly with the "quantity" along an isopleth; for instance, the elevation along a 20-foot contour line is something real and quite different from that of the density of 20 people per square mile along the 20 isopleth.

CLASSIFICATION OF ISOPLETH MAPS

The classification of isopleth maps used here is based upon the types of ratios shown by these maps. The word "ratio" is not restricted to its limited mathematical meaning where the dividend and divisor are in the same units, but refers to a "Fixed or approximate relation, as between things or to another thing, in number, quantity, or degree; rate; proportion." (Webster). The ratios that are recorded by isopleth lines express the relation between one kind of data and another, such as population and land, acres in wheat and acres in cultivated land, or miles of road and number of farms.[4] In each instance the ratios are derived from the proportion of a dividend to a divisor and it is upon the characteristics

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Professor Mackay's "Dotting the Dot Map" was published in the January–March 1949 issue of SURVEYING AND MAPPING.

of these that the system of classification is based. It is realized, of course, that some borderline types are difficult to classify according to the proposed system, but they are relatively few in number.

In the first type, the dividend and divisor are either in the same unit, or the dividend is included within the broader category of the divisor. As an illustration, the dividend may be horses, and the divisor either horses or farm animals. Since the dividend is a part of the divisor, this type of isopleth map shows proportions and percentages, such as ½ or 50 percent of land in wheat. Many common distribution maps are of this kind.

The second type has the dividend and divisor in unlike units, with the divisor the total area of the statistical division. The reason for the limitation in the divisor is that these maps are distinct from those density maps where the divisor comprises only a portion of the total area of the statistical division. The essential difference between the two becomes evident in the results which may be obtained through map interpretation. As an illustration, since population density = $\frac{\text{people}}{\text{area}}$, the approximate population in any area may be easily computed by multiplying area and density. On the other hand, if the divisor is a portion of the area of the statistical division, such as in a map of the population density per square mile of cultivated land, there is no means of determining either the number of people or the area of cultivated land in any region. The map merely expresses a ratio, and the population may be numerous or few and the cultivated land large or small. Thus a map of population density is included in the second category, while one of the population density per square mile of cultivated land is excluded.

Before a density of population map can be drawn, the area of each statistical division must be known. This information is often difficult to obtain, even though the boundaries are delimited on maps. The reason is that areas enclosed by the boundaries may exceed those to which the statistics apply. For example, the incorporated area of a city must be subtracted from that of the township in which it lies if a map is to be drawn of rural population density, because statistics for rural population are given only for the unincorporated areas. An excellent illustration of the problems involved is that of determining the areas of census subdivisions for the decennial censuses of Canada. The areas of the census subdivisions are not in the census volumes, although their boundaries have been delimited on some maps. In such cases, the cartographer may frequently select a plotting method which is independent of areas and use dots or some other symbol placed within the boundaries instead of isopleths.

The dividend and divisor in the third and last type are in different units. Since there is virtually no limit to the choice of units for either one, the variety of possible ratios is indeed great. Not all ratios that may be calculated are, however, significant;

TABLE I

ISOPLETH MAPS SHOW DIFFERENT TYPES OF RATIOS

Types	*Dividend and Divisor*	*Examples of Ratios*
Percentages, Proportions	Same units or with dividend a portion of the divisor	$\frac{\text{20 acres wheat}}{\text{200 acres cultivated land}} \times 100 =$ 10% of cultivated land in wheat
Density	Different units with the divisor the total area of the statistical division	$\frac{\text{3500 people}}{\text{100 square miles}} =$ population density of 35 people per square mile
General ratios; value of distribution, number, size, yield, etc.	Different units	$\frac{\text{3500 people}}{\text{70 square miles of cultivated land}} =$ population density of 50 people per square mile of cultivated land
		$\frac{\text{14,000 acres in farms}}{\text{100 farms}} =$ average size of farm of 140 acres
		$\frac{\text{260 bushels of oats}}{\text{10 acres in oats}} =$ yield of 26 bushels of oats per acre

there is no meaning in a map showing the number of telephone poles per acre of potatoes for the United States. On the other hand, there are a great many ratios which are significant, and in this third type we can expect the greatest progress in the development of new and meaningful ratios.

The drawing of an isopleth map is not a simple and straightforward procedure, although it is often treated as such. It is frequently subject to greater individual variations in judgment and skill than is usual with isometric maps. This arises from several different factors inherent in each type of map. In drawing an isometric map, the cartographer does not choose the positions of the numbers which he is plotting and he is often guided in his placement of lines by a knowledge of the distribution which he is mapping. Thus the draftsman of a contour map is aided by his "topographic sense." In isopleth mapping, the cartographer deals with ratios for areas and not points, and he cannot always rely upon any "sense" to assist him in the placement of his lines.

The problems which require particular attention in isopleth mapping are the locating of the control points (the points which are chosen as representative of the statistical divisions), placing of the isopleths, selecting the isopleth or class intervals, and the reliability of the ratios.

LOCATING THE CONTROL POINT

There can be little divergence of opinion in selecting the control points where the statistical divisions are symmetrical in shape with distributions assumed to be even. In the familiar rectangular division, the control point would be placed at the intersection of the diagonals. Frequently, however, statistical divisions are irregular in shape, especially in countries or areas where surveys followed long after settlement; in such cases, the grid pattern of land subdivision was rarely used. In addition to irregularity in shape, an uneven distribution will also influence the selection of the position for the control point.

Whether regular or irregular in shape, even or uneven in distribution, the most representative point is probably the center-of-gravity or pivot point where the distribution would balance if it were supported by a rigid and weightless plane.[5] For example, the center-of-gravity for the population of a township would be the point of balance if the total population were supported by a rigid and weightless plane, each person exerting an influence on the center-of-gravity proportional to his distance from it.

If the distribution is assumed to be even throughout a statistical division, the center-of-gravity coincides with the geographical center-of-area (fig. 1, A and B). The center-of-area is the special case of the center-of-gravity where the distribution is even or uniform. The center-of-area for any shape of figure is the pivot point on which it would balance if it were cut out of some uniform material such as cardboard and supported by a rigid weightless plane.

The center-of-gravity is not the only possible kind of center, although it is probably the most accurate and easily calculated type that is suitable for determining the position of the control point. There is, for instance, the bisector-center-of-area which is located at the intersection of two lines which bisect the area. The bisectors are usually chosen to intersect at right angles, such as in the meridian-parallel grid system. The orthogonal bisectors divide the area so that half lies on each side of each line. There are two main disadvantages to this type of center. In the first place, different centers may be obtained by varying the bisectors and so there may be numerous centers.[6] In the second place, the center is adaptable only to the case of an even distribution and is not suited to an uneven case. On the other hand, there is only one possible center-of-gravity for an area and the center is equally suited to a uniform or variable distribution.

Another type of center that has been especially popular in studies of population movements is ". . . the point at which the entire population could assemble with the minimum aggregate travel, each individual travelling directly."[7] Although normally applied to population analyses, the method may be used in other kinds of areal investigations. The advantages of this type of center are outweighed in isopleth mapping by the fundamental disadvantage of difficult calculation. It is much easier to estimate visually the center-of-gravity, with which everyone is more or less

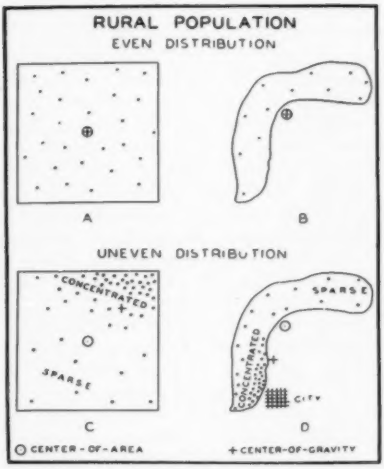

FIG. 1. The four diagrams of statistical divisions show possible locations of the center-of-gravity and center-of-area for uniform and variable distributions, with rural population used as an example. They serve to illustrate the problem of locating the control point in regular and irregular shaped divisions. In A, which is rectangular, the center-of-gravity and center-of-area clearly coincide at the intersection of the diagonals. Because the distribution is even, the centers in B also coincide, but they lie outside the bean-shaped area at a point which is more representative of the whole division than any point within it. The distributions are uneven in C and D so the center-of-gravity is displaced away from the center of area. In each case, however, the center-of-gravity is probably the most accurate location for the control point.

familiar, than that of the unfamiliar center-of-minimum-aggregate-travel.

If the distribution in a statistical division is assumed to be even, the center-of-area will usually lie within its boundary. If, however, the division is irregular in shape the center may lie *outside* rather than inside its boundary (fig. 1-B). When the center-of-area lies outside the division, such as frequently happens in a bean-shaped area, it is generally preferable to place the control point at the center-of-area instead of arbitrarily keeping it within the boundary of the division. The outside point may be far more representative of the whole division than any point that may be selected within it.

When the distribution is uneven, the control point should, if possible, be placed at the center-of-gravity. The center-of-gravity will be displaced away from the center-of-area, the amount of displacement varying with the distribution (fig. 1-C and 1-D), although sometimes the two may coincide purely by chance. It is generally difficult, if not impossible, to determine the precise location of the center-of-gravity but nevertheless it is probably better to shift the control point towards its estimated position than to ignore it completely. A detailed knowledge of the distribution which is being mapped will often assist the cartographer in judging where the center-of-gravity should be located.

In some statistical divisions there are negative regions, such as lakes and swamps, where the distribution which is being mapped may be sparse or absent. Allowances can be made for some negative regions in dotting dot maps, but the problem of compensating for them is difficult with isopleths. Under most conditions, small features such as lakes cannot be shown on a black and white map without danger of having them confused with the isopleths. There is virtually no means of refining the accuracy of isopleth maps by making adequate provision for the elimination of small negative regions such as may be done with dot maps.[8]

Where the control points are sufficiently numerous so that the map distances separating them are relatively small, the problem of locating the control points by the center-of-gravity method is of little to no practical importance. Any small shifting of the control points would be negligible in their effect on the accuracy of the map and the positions of the isopleths. The necessity for precision in locating the points increases with their separation and the scale of the map. It becomes of paramount importance in large-scale maps with few control points. In such cases the accuracy of the map is determined not only by the statistics but also by the care with which the control points are located.

PLACING THE ISOPLETHS

An isopleth line is positioned by interpolation and inference with reference to numbers at control points. If every location on a map had only one possible value, isopleths could be plotted easily by linear interpolation. Unfortunately for the accuracy of the map this is often not the case. There are two possible values for every

position that lies between opposite "pairs" of control numbers if one pair lies above, and the other below, the value of an isopleth (fig. 2-A).

In figure 2 there is an illustration of the problem which continuously plagues the cartographer in the placement of isopleths. The numbers at positions A, B, C, and D can be considered as greater or less than 5 depending upon which pairs are used for interpolating their values. Thus the number at A could lie between 1 and 4, or 8 and 6; similarly, those at B, C, and D could lie above or below 5. Since each of the four numbers at A, B, C, and D could be considered with equal validity—in the absence of other evidence—as either above or below 5, a total of 16 different isopleth maps could be drawn by using only the 5 ratio (figure 2-B and 2-C are two examples).

Another example is given in figure 3 which shows 10 percent isopleths for the decrease in rural population in Eastern Ontario during the decade from 1901 to 1911. The two maps in the figure have been drawn from the same census data but wherever a number could be either above or below 10, it was considered below 10 in the top map and above 10 in the bottom map. As a result, the 10 percent isopleths differ considerably between the two maps. Neither is better than the other and the best map would be a compromise between them. If two competent individuals were to draw the isopleths without any supplementary information to assist them, it is clear that dissimilar maps would result.

In drawing many isopleth maps, there is frequently little information to aid the cartographer in placing the control points at the centers-of-gravity although it is known that the distribution is uneven. Nevertheless, he may be able to shift the isopleths to more accurate locations by studying the general distribution and values of the control numbers. As an illustration, rural population density increases near large cities and the cartographer can take this generally known fact into account in the placement of the lines; another example would be where control numbers at equally spaced control points change rapidly in one direction, such as 10, 20, 40, 80, and 160. It is evident that linear interpolation would be inaccurate, because number 15 is almost certainly nearer to 20 than to 10; 30 to 40, than to 20; 60 to 80, than to 40; and 120 to 160, than to 80.

SELECTING THE ISOPLETH INTERVAL

Selecting the isopleth interval presents a problem to a cartographer comparable to the arrangement of camera, light, and subject to a photographer. In each case, the results can be varied and controlled within limits in order to achieve certain desired effects. A cartographer can utilize his choice of isopleth or class intervals to produce a graded sequence of maps which will vary greatly at the extremes, although all were drawn from the same data.[9]

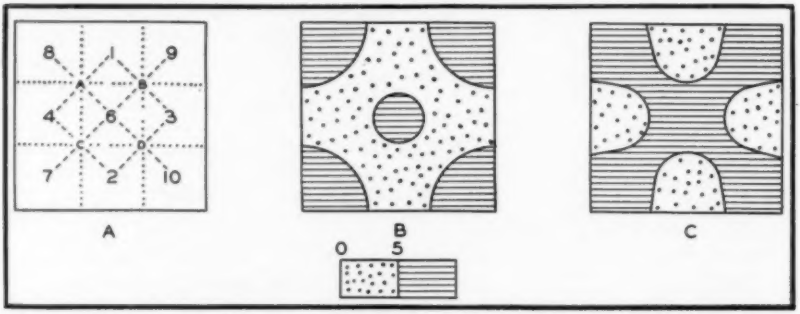

FIG. 2. The nine control numbers in diagram A have been chosen so that certain "pairs" of control numbers are above 5, and others are below 5. When the value of a number intermediate between four control points is being interpolated, it may be considered as above or below 5, depending upon the "pairs" of control numbers used in determining its value. Diagram B has been drawn on the assumption that the values of the numbers lying between control points are below 5, and diagram C with the numbers above 5. Since there is no supplementary information which may be used in making a choice, the matter is entirely one of personal judgment and many maps could be drawn from the same data.

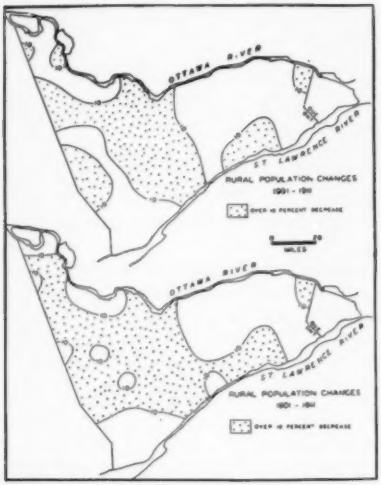

FIG. 3. The theoretical problem illustrated in Figure 2 is shown by two practical examples in these two maps which have been drawn from the same census data. Wherever a number could be considered as either above or below 10, it was chosen as below 10 in the top map and above 10 in the bottom map. In this particular case, supplementary information could be obtained by studying rural population changes in the preceding and following decades. With this information as a guide, a fairly accurate estimation could be made of the values which should be accepted or rejected.

If numerous isopleths are plotted with small class intervals on a map with widely separated control points, the reader is given a false impression of high accuracy. If the intervals are excessively large with reference to the control numbers and points, significant variations in distribution may be lost in a generalized and featureless map. If the intervals increase or decrease, ratios at the lower or upper end of the scale will be emphasized. The two maps of sheep per farm in figure 4 have been drawn from the same ratios except with different class intervals. Those in the top map increase in steps of 1, 2, 4, and 8, while those in the bottom map are the reverse order, namely 8, 4, 2, and 1. The result is to accentuate areas with few sheep per farm in the top map and those with many sheep per farm in the bottom map.

Isopleth intervals are often chosen in arithmetic or geometric progression, but are also varied in no systematic manner, such as in 0, 5, 10, 50, and 100. There is a practical limit to the complexity that may be introduced into the class intervals, because map interpretation becomes too difficult if they deviate excessively from a simple pattern.

As an aid in selecting isopleth intervals, the ratios may be plotted in graph form. A convenient method is to use a frequency graph where the number of cases (the frequency) is plotted along the Y-axis and the ratios along the X-axis.[10] The frequency graph will show both the range of distribution and its concentration, if any, at certain ratios. Low-frequency ratios may then be tested on the map for their suitability as isopleths. It is essential to check the positions of the lines on the map, because a graph is like a census table in that it places together data which are geographically separated.

As a general rule, isopleth intervals should be chosen to avoid excessive numbers of isolated "islands" of highs and lows, and should coincide with rapid, rather than gradual, changes in distribution. An isopleth is usually best employed to separate

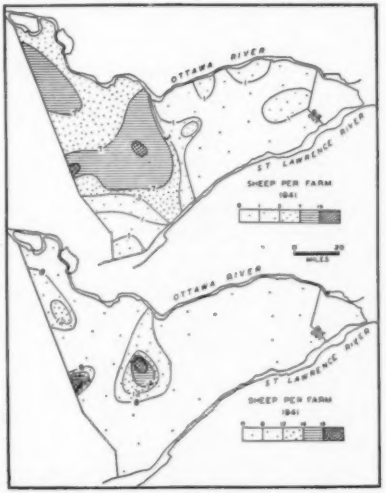

FIG. 4. These two maps have been drawn from the same ratios but with different class intervals. Those in the top map increase in steps of 1, 2, 4, and 8, whereas those in the bottom map increase in the reverse order, namely 8, 4, 2, and 1. The result is to accentuate areas with few sheep per farm in the top map and those with many sheep per farm in the bottom map.

regions of diversity instead of near uniformity.

RELIABILITY OF RATIOS

Since isopleths show ratios and not absolute quantities, identical ratios may differ considerably in their reliability. For example, two townships of the same size could have 10 percent of their cropland in wheat but if one township had only one farm while the other had one thousand, the reliability of the two 10 percent ratios would not be comparable. If, however, the isopleth map was accompanied by dot maps showing the distribution of wheat, cropland, and farms, the reader would be able to estimate the reliability of the ratios. An excellent method of supplementing some isopleth maps is to prepare companion maps, such as dot maps, to give the reader a broader background with which to interpret the maps.

SUMMARY AND CONCLUSIONS

A large variety of quantitative distribution maps are grouped within the general category of isopleth maps. These maps show different kinds of ratios and may be divided into three types upon the basis of their dividends and divisors. Some of the particular problems which arise in isopleth mapping involve the locating of control points, placing of isopleths, selecting the intervals, and reliability of the ratios. These problems are of comparatively little importance in small-scale maps with numerous closely spaced control points, but they increase with the scale of the map and the separation of the control points. Since each problem is subject to the variations of individual interpretation, the accuracy, usability, and appearance of many isopleth maps reflect the cartographer's knowledge and appreciation of the special problems and techniques inherent in isopleth mapping.

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ROUTE SURVEYS

This is a revised edition of a pocket book for the survey, design, and construction of railways, highways, tramways, beltways, canals, flumes, levees, pipe lines, transmission lines, and other route constructions. Written by H. Rubey, it begins with the reconnaissance, proceeds through a detailed discussion of location, curve layout, excavation and embankment, etc., with emphasis on practical procedures. Nearly 300 pages are devoted to data tables for quick reference in the field.—*Civil Engineering*, October 1951.

Dependence of Oil Industry on Adequate Mapping

By GEORGE H. LACY

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ALMOST 100 YEARS AGO the petroleum industry was born when oil was discovered in Pennsylvania; although oil had been found in many places throughout the world, its use had been limited to oil lamps and lubricants in a very small way. When Mr. Drake brought in his discovery, he certainly did not visualize the important role that oil would play in the advancement of civilization and the place it would take in our everyday life.

By giving you a few facts and figures, I shall try to illustrate the rapid growth of this industry.

The oil industry owns and operates more than 150,000 miles of pipe line; and, in addition to the pipe-line transportation, the industry utilizes 103,000 tank cars, 250,000 motor transports, 500 tankers, and 2,400 barges for transporting crude oil and its products. According to recent information, American farmers use more than 10 billion gallons of oil products yearly for petroleum fuels. Lubricants are made for the 3,150,000 farm tractors and 15,000,000 mechanical farm implements in use on American farms today. Approximately 5 million automobiles and 2 million trucks are used by farmers alone. One-third of the farm homes in the country are lighted by kerosene or gasoline lamps or by electricity by petroleum-powered generators. Also, bottled gas or liquid petroleum is used for cooking, heating, and gas refrigeration in more than 5½ million homes in this country.

Other by-products stem from petroleum. For instance, I am sure some of you husbands have explored the depths of your wife's handbag (unknown, of course, to your wife) in search of car keys, or maybe a little loose change, and in this exploration you have found a number of by-products of petroleum, such as cosmetics, plastics, etc.

The total number of wells drilled in Texas alone, throughout the years to January 1, 1949, was over 256,000. This includes producers of oil and gas, dry holes, and wildcat wells. In 1948, 2,285 wildcat wells were drilled in Texas.

IMPORTANCE OF ADEQUATE MAPS

The reason for going into these facts and figures is to lead up to the importance of adequate maps over the country, especially to the petroleum industry. For instance, to drill over 2,200 wildcat wells scattered throughout Texas means exploring areas which have not produced oil, and usually areas which are not easily accessible by our modern transportation methods. From this you can imagine the complex problem confronted by the industry when you think of the wildcat drilling throughout the entire United States. Appropriate maps are needed by the geophysicist and geologist, and by the engineer in selecting routes into the areas being considered for the drilling of wells.

For instance, when the geophysicist selects an area to be investigated, the first question that arises is what maps are available and to what extent do they show the topographic features and the subsequent surveys and subdivisions indicating

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ownership. Contour maps are invaluable to both the geophysicist and the geologist. From these maps they can obtain ground control as well as elevations. Elevations are important to geological studies as well as to the actual drilling of the well. For example, some years ago our company drilled a wildcat well where it was necessary to run approximately 10 miles of levels in order to establish an elevation at the well site so that the geologist could correlate the formations as the drilling of the well progressed.

In the early days of the oil industry, the "wildcatter" was a rather colorful figure, and his methods were haphazard as well as crude. He selected a drilling site perhaps by the flip of a coin or by some other method just as scientific. The "doodlebug," or divining rod, was used quite extensively; and, according to some of the oldtimers, it was used very successfully.

BASE MAPS AND AERIAL PHOTOGRAPHS AID PRELIMINARY SURVEYS AND FIELD INVESTIGATIONS

Although science has not taken all the risk out of prospecting for oil, very few exploratory wells are now drilled without the benefit of extensive surveys based on the most advanced knowledge of geologists, geophysicists, and paleontologists. After the geologist decides, on the basis of preliminary survey, that the presence of oil is possible, a geophysicist is usually called in to determine the formations with more exactness. This is done by various methods, such as gravity measurements, refraction and reflection seismograph surveys, and core drilling. In connection with the last, a paleontologist's services are usually required. It is obvious that an accurate topographic map can render invaluable assistance in correlating the data thus secured.

In conducting this investigation, the geophysicists must have up-to-date ownership maps, as a permit must be secured from the landowner before entering his property. In some instances, an option is taken on a large area with the understanding that, after the exploratory work has been completed, a selection may be made for drilling purposes.

In compiling ownership maps, we have found that a topographic map at a scale of not less than 1:31,680 and, in the area under discussion, with a 1-foot contour interval insures the most reliable base. In recent years, we have used aerial photographs in conjunction with the topographic quadrangles. These maps, having positions and elevations for ground control, are invaluable in completing a serviceable map. Of course, the fact that roads, streams, and other natural and artificial objects are shown on the map does not eliminate the need for an actual survey, but it greatly facilitates the progress of the work.

After a block of leases and the well site have been selected, the next question is what type of terrain will be encountered. In this modern age, heavy equipment is used to drill wells, particularly those at depths exceeding 10,000 feet. For instance, a single unit may weigh from 20 to 37½ tons; therefore, a route must be selected over which an all-weather road may be built to support such traffic. Naturally, it is advantageous to have some idea of the drainage in the area in order to determine bridge or culvert sites. Furthermore, if this particular area is found to be productive, it is then necessary to locate a system of roads, erect tank batteries, and make other developments pertinent to the maintenance of oil production.

In an area that has been adequately mapped, these roads in many instances are located and preliminary estimates furnished before any field work is actually done on the ground. We have used this method frequently, and on one project

15 miles of road were located in the office; when the roads were actually located on the ground, only one minor change was necessary.

USES OF TOPOGRAPHIC MAPS

These topographic maps not only serve in what we term "wildcat" drilling, but, after the field has been fully developed and the drilling completed, there is the problem of the disposal of salt water, or, as we call it, bleed water, from the tank batteries. Where possible, the tank batteries on each lease are located as centrally as possible to the operations and on a high point of the lease. There are two common designs of gravity systems for disposal purposes, the most satisfactory being disposal wells. These wells are drilled below the depth of fresh water supply into a porous sand, and the salt water is injected therein. The other method is to build an earthen storage reservoir. Naturally, these disposal points must be located at such levels that the gravity system will operate.

The next step in using topographic maps is to locate trunk pipe lines. This is a very expensive construction project, and, in order to operate these lines efficiently, care should be taken in selecting the routes. Using topographic maps and aerial photographs, the preliminary survey can be made in the office, and the locating engineer is advised in advance as to the topography to be encountered. The pump station sites along the line may also be selected in advance, as well as camp sites or other structures pertinent to the operation of the line.

COOPERATIVE TOPOGRAPHIC MAPPING PROGRAM IN TEXAS

Many of you are probably not aware of the fact that considerable effort has been made by Texas State officials, civic organizations, and influential individuals during the past few years to initiate a cooperative topographic mapping program between the State and the U. S. Geological Survey. At present, according to the latest information I have, about 12 percent of Texas is covered by maps made by the Geological Survey that can be considered adequate or usable. In addition, about 4 percent of the State has been mapped by other agencies in such a manner that the maps can be used effectively for present-day needs. Reconnaissance maps are available for another 22 percent of the State, but these are of little value for modern map usage.

Topographic mapping in Texas was carried on entirely with Federal funds until about 1901, and was continued at intervals from 1902 until 1917 and continuously from 1920 to 1932 in cooperation with various State agencies that provided part of the required funds. Just prior to World War II, the Geological Survey undertook the now-completed mapping of nearly 3,000 square miles in the vicinity of El Paso, largely for national defense purposes. During the war, a further national defense mapping program was conducted in Texas, a great part of which was located in the eastern part of the State. At the end of the war, using funds transferred from the Corps of Engineers Office for the initial stages, a program to map approximately 2,000 square miles in the vicinity of Tyler and Palestine was undertaken; and, in another program, the Geological Survey compiled maps, using Army funds, of the Camp Bowie and Camp Maxey areas. At the request of the State Board of Water Engineers, the Geological Survey this year undertook the mapping of an area of over 1,000 square miles (sixteen 7½-minute quadrangles) in the vicinity of Colorado City to provide topographic data for the water-development program on the Colorado River. Other topographic mapping programs in various stages of planning or execution are: the Red-Ouachita Project, on the Red River; southeastern Texas adjoining

the Gulf of Mexico; Oakville and Sanford Reservoir sites; and the Dallas and Fort Worth metropolitan areas.

TWENTY-FOUR STATES NOW USING SIMILAR COOPERATIVE MAPPING METHODS

During the past 2 years, the Texas Board of Water Engineers, the Texas Water Association, and others within the State have been striving for the initiation of a cooperative mapping program of considerable magnitude. As you may know, a good part of our topographic mapping is done by cooperative programs wherein the States provide half of the funds. At the present time, 24 states are participating in such topographic mapping. The largest program is in Kentucky, which is providing $830,000 a year for topographic mapping; other States are providing smaller amounts, of which some of the largest are California, $300,000; Minnesota, $80,000; and Tennessee, $67,000. A bill was introduced in the Texas legislature for the appropriation of $200,000 per annum for 2 years for topographic mapping. This bill was not passed by the legislature. Considerable interest has also been shown in the past 2 years by officials from Dallas and Tarrant Counties in a cooperative program financed by the counties.

The reason that Texas has been discussed principally is that I am more familiar with the need for maps in Texas than in any other States, although I feel sure that the same need exists in the State of Louisiana.

* * *

Visible Lightning Bolt Is Earth-to-Cloud Bound

The brilliant flash of lightning seen by the human eye is traveling from the earth to a cloud, not from cloud to earth as generally thought.

That is one of the basic facts about lightning which General Electric scientists in Pittsfield, Mass., have used in conducting lightning research during the past 25 years. The flash seen by the eye, spurting from the earth to a cloud, travels at a rate of some 18,000 miles per second, according to Julius H. Hagenguth of the GE laboratory.

He explained that as a lightning charge is building up in the clouds, an opposite charge is building up on earth. The stroke travels slowly from the clouds, invisible to the eye. When it contacts the ground, the brilliant flash which is seen spurts from the ground toward the sky.

There is still much to learn about lightning although many questions have been solved by experimental work in the GE high-voltage laboratory where a 15,000,000-volt jolt of artificial lightning can be obtained with the flick of a switch. Included are some facts which are contrary to long-time beliefs.

Lightning often strikes twice in the same place, Mr. Hagenguth states. The Empire State Building in New York City has been struck as many as 48 times in a single season. With the new 222-foot television antenna atop the 1,250-foot structure, more frequent strikes may be expected.

The lightning rod on a building does not ward away the negative bolt with positive charges from the earth. Actually, it intercepts the lightning and conveys it safely away to the ground, thus preventing its flow through vulnerable parts of the structure. The lightning rod is still the home-owner's best protection against the ravages of lightning, he stated.—*Science News Letter*, August 4, 1951.

Problems of a Property Surveyor

A new member of the American Congress on Surveying and Mapping, H. C. Robinson, an engineer and land surveyor of Worcester, Mass., wrote to the ACSM about conditions in the field of property surveying in his locality and asked for any recommendations to solve or overcome the difficulties and wondered whether similar troubles were encountered in other parts of the country.

According to usual practice, Mr. Robinson's inquiry was referred to the Property Surveys Technical Division. Wm. C. Wattles of Glendale, Calif., the then Chairman of the Division, answered the inquiry and sent copies of the correspondence to several competent members of the Division, asking them also to write to Mr. Robinson. S. A. Bauer, engineer of Cleveland, Ohio, and past president of ACSM, and William T. Fairclough, engineer for the Massachusetts Land Court, also wrote to Mr. Robinson.

Inasmuch as the conditions and difficulties Mr. Robinson described are commonly encountered in various parts of the country, many of our members should be interested in these problems, so the pertinent parts of the correspondence are reproduced here. If any readers have contributions to make, the "Comment and Discussion" section of this Journal is open to all.

—EDITOR

ITEM 1

In this county there are 12 listed surveyors while 50 or more are actually practicing. The difference is made up of city and State employees, students, contractor employees, etc. They have no overhead or costs incidental to running a business. Consequently their charges are out of our competitive range.

Comment by Wattles.—No surveyor should be allowed to practice unless licensed by State law, license being granted after passing a rigid examination comprising all departments of knowledge required for high standard of practice. This will prevent, *if the law is enforced,* much of the shoddy work now done.

Any surveyor gainfully employed by governmental or private organizations should be prohibited from private practice in competition with free lance surveyors.The reason is obvious. The City of Los Angeles and the County of Los Angeles both prohibit private work by their employees, although this regulation is not 100 percent effective.

The matter of fees is an ethical one, and can be adjusted only by cooperation among local surveyors. The base is cost, reasonable return, and value for quality of work. If the public can be educated to pay a fair price for good work and refuse to accept shoddy experiments, the chiselers will have to quit.

As long as a man operates as a subordinate, and does not make decisions or act as a principal in survey practice, he need not be licensed, but when he becomes a responsible party, his activities should be controlled.

Comment by Fairclough.—Organize the 12 listed surveyors and as many others as possible into an association, the purpose of which would be to bring the members into closer touch with one another, promote mutual understanding and interest, and generally advance the profession of land surveying. The surveyors on Cape Cod have an association which has been active for 2 years, and they are making very good headway toward new ideas. At the present time another association is being formed, called the Eastern Massachusetts Association of Registered Engineers and Land Surveyors. Its purpose is about the same as that of the Cape Cod association.

ITEM 2

Some plans being recorded indicate "fudging" or have a course or distances omitted so that no closure can be computed or run out on the ground. Many plans show monuments, evidently proposed but never installed. Some plans have to be reconstructed on the ground by running from known points at a considerable distance from the site. Others cannot be run at all, without setting arbitrary initial points. Yet such plans are accepted for official record and future reference. It is apparent that either there are no regulations to correct these failings or they are not enforced.

Comment by Wattles.—The cure (partial at least) for "fudged" or insufficient maps of record, is a strong, workable, and *enforced* map law, defining the style, information, accuracy, and method of check required for all

maps to be recorded, and prohibiting the use, by reference, of such maps, in descriptions of property, until the law has been complied with. California has such a law, and it is reasonably well enforced by city, county, and State offices, and by the Real Estate Commission; the checking is handled by the city engineers, county surveyors, and, where titles to the land are to be issued, by the engineers of the title companies; the bug is that because of lack of funds or personnel, dependence on field accuracy lies with the map check and an occasional inspection in the field.

There should also be a law requiring filing of maps of surveys wherein the surveyor has found material discrepancy with the record, or where he has found and replaced old monuments. The maps should show *all* dimensions, descriptions of points found or set, and any other notation regarding the analysis or manner of determination of boundaries.

Comment by Fairclough.—Adopt a set of standards, adaptable to your locality, using the TECHNICAL STANDARDS FOR PROPERTY SURVEYS, adopted by the American Congress on Surveying and Mapping as a guide.

ITEM 3

Land Court staffs are so undermanned that they are unable to provide on-the-site checks of surveys which are to be registered; plans are accepted if the computations and the appearance of the plans meet their requirements.

Comment by Wattles.—Understaffing of control agencies is common. Apparently there is little that can be done about it other than by suggestion to increase the efficiency of operation of the staffs, and try for better performance of the surveyors. The Land Court staff, if sufficiently experienced, can, in many cases, smell trouble, and spend a bit more time in verification and field inspection. If the worst is indicated, probably the Court is in a position to demand from the land owner another independent survey by some surveyor considered by the Court to be competent to handle the problem; a comparison of the two surveys will likely provide an answer or an adjustable situation.

Comment by Fairclough.—The Land Court engineering departments are undermanned. This could be corrected if all surveyors in Massachusetts would bring the matter to the attention of their State senators and representatives. There is a definite need for field crews to check surveys to be filed, and particularly to check faulty subdivisions of registered cases. Determination of property lines in cases where monuments have been lost or where they were never set should be another duty of the field crews.

ITEM 4

When deeds or plans are found to be in error, most laymen, as clients, do not believe that they should go to the expense, or that it is important enough, to file corrected deeds or plans.

Comment by Wattles.—Land owners as a class are in the same category as automobile purchasers—they think the original cost should be the last, and no maintenance. If the acquisition of the land was not verified as to title or correctness of physical boundary, there then must come a time when adjustment is necessary, and surveys must be paid for—necessary, inevitable.

Comment by Fairclough.—Educating the client on the importance of the recording of accurate records and surveys seems to be the only solution to this question.

ITEM 5

When Public Works Department monuments are found disturbed or incorrectly set, we are informed that the curve is not tangent to the tangents or are requested to hold the monument as is and show its variation from true locus. It is often impossible to decide which of the monuments is the one to be held to establish the true locus of another. Obviously it is unfair that a client should pay for the time and service necessary to correct for these difficulties. Yet it is equally unethical to submit a solution without the correction.

Comment by Wattles.—Public Works monuments or any others, if they can be shown to have been misplaced or disturbed, or incorrectly set or reset, can (by legal means if necessary) be legitimately ignored in favor of a correct relocation of the position called for in the deed. If there is no deed, the monument may become definitive as a prescriptive position; or long time use in the incorrect position, and occupation which would be disturbed by change, may establish title by ad-

verse possession; but the erroneous monument cannot be forced as superior to a correct position defined by dimensions in the deed, if the error can be shown.

Any survey and map including the area affected by erroneous monuments should make ties to such monuments and show the actual offset to the true corners.

We agree that the client should not be subjected to excessive or unfair expense in adjustment of lines, especially those in which the public service departments are at fault. The public service should realize this and if not voluntarily, then a certain amount of coercion might produce results.

Long lines between private holdings can often be retraced and monumented in adjusted position through cooperation and joint payment by adjoining owners.

If laws and enforced regulations on recording of maps are in being, the problem of relocation is easier.

If worst comes to worst, the client will not pay over a certain amount, the relocation is excessive in proportion to the value of the instant land, and the adjoiners will not cooperate, yet you want to give your client as much as possible, then tell him what you can do, what assumptions you can make, what results you will get, with probable limits of error; make the survey as outlined, make a map showing what was done and make plenty of notes thereon, stating the precise status and acceptability of the lines and corners shown; also make a written report to the client, advising him of steps which may be taken to adjust the difficulties. This will give your client his money's worth, and avoid getting yourself classed as a poor or careless operator; it will also furnish some other surveyor working in the area with data valuable in getting an eventual sound arrangement of boundaries.

Comment by Fairclough.—As far as the Land Court is concerned, monuments set by State, county, or town highway engineers should hold over the courses and distances. Attention to obvious errors in setting the monuments or damage to the same should be called to the attention of the proper authorities so that they may be corrected.

ITEM 6

There should be some local source of recorded and absolute coordinated locations and descriptions of Federal and State traverse stations. As it is now delays are incident to obtaining these data through the mails or traveling to other cities for them. It is my belief that a file maintained locally, and available to the public, would lead eventually to all surveys being tied to these marks.

Comment by Wattles.—Accurate and associated surveys may be made and, through recordation, became a valuable part of the survey net in your State. The Coordinate System, of course, is the logical thing, but, until the Coast and Geodetic Survey or some other government agency establishes the base controls, local systems must supply the need. Bear in mind that any system is valuable for controlling survey accuracy only; the titles will still follow the descriptions in the deeds, whether good or bad; only new deeds and adjusted boundaries described with reference to the new coordinates, and accurately monumented by the same coordinates, will give the coordinates standing in title.

In Los Angeles County and City, the county and city engineers have established a great network of road and street centerlines, well measured; they have broken down the original C. & G. S. net of triangulation into some 1500 secondary stations, and have, in addition, connected with a large number of the centerline intersections, determining the coordinates thereof. Thus, under public expense and activity the private surveyor has access to the coordinate data he needs.

Comment by Fairclough.—The Massachusetts Geodetic Survey, under the direction of Elmer C. Houdlette, Department of Public Works Engineer, has a complete file of all coordinated Federal and State triangulation, traverse, and benchmark stations. The Land Court has recently received copies of this complete file. It is our intention to furnish each Registry of Deeds with copies of these records that are pertinent to that particular district. We assume that practically all Land Court surveys have their inception at the local Registry of Deeds, and as some Registries have photostating facilities, the surveyor's problems would be simplified by having copies easily obtainable at this source.

ITEM 7

In surveys along water courses, resultant plans show open traverses. Some practice should be adopted to permit their

closure and to eliminate "high," "mean," or "low-water lines" or "thread of stream" as definitive of boundaries.

Comment by Wattles.—The "water line" or "thread of stream" has been a revered and visible boundary for these many years; it would be quite impossible to eliminate such calls in the present ideology of human thinking; nor can you survey the exact line of such thread of stream, since it is as jumpy as a will-o'-the-wisp. Therefore, we must accept for the particular worth of it, the recital in a deed that the boundary is the "center of the creek; thence along said center, S 37° E 20 rods" knowing the course does not fit the center, and knowing the center will be 6 or 8 feet off position next winter.

The solution, of course, is an agreement deed between adjoiners, fixing a line by metes and bounds, tied to definite corners or monuments, and eliminating the creek as a monument, even though the line runs down the creek.

Comment by Fairclough.—The Land Court does not determine in most of its decrees the boundaries of ponds, rivers, creeks, or seashores. It has always been the practice to use natural monuments such as these and probably it will always be so. We do require that the water lines be located from survey base lines and that these lines be incorporated in a final traverse.

ITEM 8

Some universal legal recourse should be available in instances where boundary markers are intentionally disturbed.

Comment by Wattles.—Many States have laws specifying penalties for disturbance or removal of survey or boundary markers. The Federal Government has such a statute respecting monuments set by the various departments. Some laws provide for removal or replacement of monuments by authorized surveyors, provided a record is made of such acts.

Comment by Fairclough.—I thought there was an act passed by the (State) Legislature making it a criminal offense, punishable by fine or a prison sentence, to remove or destroy any property line bound. I have looked up the reference that I had, but I find that the reference is incorrect. Such an act has been passed, however, protecting stone bounds which mark town and city boundary lines. However, I would refer you to the original act against the destruction of boundary markers as follows:

Cursed be he that removeth his neighbour's landmark. And all the people shall say, Amen.

—Deuteronomy 27: 17

ITEM 9

A surveyor should have legal access to any properties in the pursuit of the profession, without need of writs or law officers to gain such access. Issuance of proper identification cards by proper authority might accomplish this.

Comment by Wattles.—In some localities legal access is provided for the surveyor to lands adjoining the property being surveyed, restricted, however, in that permission of owner must be obtained in case of removal or destruction of trees, shrubs, etc.

The problem is usually resolved by the attitude and persuasiveness of the surveyor in convincing the neighbor that he is getting something free in the way of location and that no trespass is intended.

It seems doubtful, otherwise, whether one should make forcible entry, even with a police permit, on peaceful business, over the objection of an owner, since "his home is his castle," and the premises are presumed inviolable.

Comment by Fairclough.—Insofar as making surveys for the Land Court is concerned, an order of Court may be applied for, so the surveyor can have access to obtain the necessary information to complete his survey.

GENERAL COMMENT BY WATTLES

You should realize that you are a very necessary part of the picture, Mr. Robinson, in that you bring to notice those things most of us think and feel but too often fail in doing anything about. We thank you for calling our attention to some "musts" for action.

May I say that the "gripes" you name are not local by any means; rather they are Nation-wide. In one form or another the difficulties plague most of us.

Correspondence and discussion of this nature needs expression; the medium we use is the Journal of ACSM, SURVEYING AND MAPPING, which goes to all members.

There are many reasons for the defections you mention, but they may be summed mainly in lack of education in basics, both on part of the surveyors and of their clients; human

cupidity and the $ sign; indifference due to ignorance of the results of carelessness and error; and to reluctance on the part of most surveyors to perform their duties with the precision, conscientiousness, and ethical and professional standards required for full and satisfactory development of the project in hand.

Since different laws prevail in different States, and local conditions and practices require a varied treatment, the surveyor must be fully acquainted with his local problems, and not venture into new fields without intensive study of conditions therein. He may, and should, bring his instant knowledge to bear on the new work, but rather as an assist than a compulsion.

In general, there is no short road to high standards nor indiscriminate privilege by the surveyor to do as he may arbitrarily decide. A get-together of the surveyors in any community, with the idea of real cooperation in all departments, seems the most logical solution. Determine the procedures necessary to produce desired results, get agreement among the surveyors, and then act. Legislation is the first and important step; then the enforcement thereof. The self-policing of surveyors by themselves will solve most of the problems. The old idea of every one for himself, the dog-in-the-manger attitude, refusal to exchange information and methods for fear of losing something(?), all *must* be discarded in favor of mutual help and confidence. As an example, in Oakland, Calif., the City Engineer keeps an open file of lot surveys made by various surveyors, the maps showing much valuable information, ties, etc.; any surveyor may examine and copy such data as he wishes. At first the surveyors were loath to furnish maps, but they soon found it to their advantage, and are now enthusiastic (that is, all except the inefficient and the chiselers, and even they take advantage of the scheme). In any event, although we can advise, it is you and your associates in your area who alone can better your conditions locally or in the State.

(Messrs. Bauer and Fairclough endorsed heartily all of Mr. Wattles' comments, and Mr. Fairclough's additional comments have been incorporated above. Mr. Bauer did not comment specifically point by point but the following are pertinent parts of his letter.—ED.)

GENERAL COMMENT BY BAUER

The problems of surveying and surveyors are not exclusively professional. In a large measure, they are the problems that arise among human beings. We are an imperfect breed. We talk brotherly love and honesty, but we don't practice it. We theorize in good will toward men, the golden rule, etc., but a large part of our breed concentrates considerably on how to take advantage of the rest of the breed.

Neither you, I, nor the ACSM is going to change these tendencies particularly, but we who have a respect, pride, and love of our profession can, by concerted effort and moral suasion, accomplish much toward improving the status of our profession.

I have been involved in local surveying organization activities for some 20 years, and, for a shorter time, nationally. Locally, our problem is much the same as yours. Fly-by-night, irresponsible, incompetent employees of practically every governmental agency are performing surveys on governmental time and with governmental equipment, contrary to specific directives from their departments. Much of the so-called professional work is not up to recognized standards, and this applies to some regular offices as well. But the situation is vastly improved from what it was when a few of us got together some 20 years ago to discuss these things.

The solution lies in the getting together, in getting the men into the same room to discuss the entire situation. Animosities tend to break down, and if they do not, then there is at least apt to be a congealing of tendencies, and at least a few of the men will recognize the wisdom and the good business of professional cooperation and unification of standards of practice.

Some years ago, after 3 years of work, the Congress developed its TECHNICAL STANDARDS FOR PROPERTY SURVEYS which are available at a nominal cost. There is nothing mandatory about these Standards, but they represent, for the first time, a professional statement of what constitutes a property survey. They have done a tremendous amount of good already, and will do more, when the practitioners realize the value of good professional practice.

The essence of the whole thing is that it is good business to cooperate, and bad business to gyp.

I like to recall a talk I heard some years ago by the sales manager of Pepsi-Cola. He was

asked how his company had the courage to enter a field so completely dominated by one organization—Coca-Cola. His answer was that, at the time of their entry into the field, there were only 8 such organizations in the country—Coca-Cola doing more than all the others put together. But, at the time of his speech, there were some 200 such organizations, with Pepsi-Cola doing more business than the original 8 combined.

Competition does not necessarily mean killing off the other man. Very often increased activity in the field increases the available business through greater publicity and greater consciousness of the desire for the product.

Certainly the cause of good surveying needs publicity. That is the job of the Congress, your job and my job. May I suggest that a few of you men actively interested in the profession get together, hold meetings, educate your colleagues, and the situation will be improved. We surveyors must lift ourselves by our own bootstraps. It is our job to do.

(After all the returns were in, Mr. Robinson wrote to thank the ACSM and specifically Messrs. Wattles, Bauer, and Fairclough for their interest in responding to his "gripes" and had this further to say—ED.):

Although it is small consolation to know that I am not alone in recognizing the practices of which I complain, it is good to find that they are being realized and combated by others who do maintain their pride and ethical standards in the pursuit of an honorable and not too remunerative trade. How many times I have heard it said that civil engineers should be on the same plane with lawyers and doctors as professional men; but how seldom does one find an engineer who enjoys the same income scale or dares to dream of the day when he can charge clients on a comparative basis for services rendered. Of course, that all boils down to the meat of the "gripes,"—that is, cheap, incompetent competition, and inadequate legislation to enforce a code of ethics and standards of performance.

I realize the need for an organized approach to curing the ills, but am not in a position to become the male Joan of Arc to conduct such a crusade. Without further "rants or raves," thanks again, and it's good to see that there is still a sense of humor among the members who have survived this tirade.

Search for Oil Aided by Magnetic Logging Device

THE SEARCH for oil deep in the earth will be aided by a new magnetic logging device developed by scientists of the Magnolia Petroleum Company. Lowered into a drill hole in the earth, it records the magnetic properties of the various layers in the underground geological formations through which it passes.

The new magnetic logging instrument is based on the knowledge that geological formations, because of their magnetic properties, distort the earth's magnetism. From a measurement of the distortion, it is possible to calculate the structure of the formation. The device is designed to supplement information acquired at the surface of the earth with the magnetism-measuring magnetometer by giving more exact knowledge of underground formations.

The instrument easily distinguishes between sedimentary rock, the type capable of holding crude oil, and igneous rocks which are often highly magnetic because of their iron content. It also measures simultaneously the electrical resistance of rock. This resistance is another property of rock which is important to petroleum geologists.

The logging device is 4 feet in length, 3 inches in diameter, and weighs 80 pounds. It is designed to withstand pressures of 10,000 pounds per square inch and, with some of its apparatus housed in a form of thermos bottle, is unaffected by temperatures up to 250 degrees F.—*Science News Letter*, May 5, 1951.

Cartographic Research and Development

(*Report of Committee of the Cartography Division*)

EARLY IN 1951 the Committee proposed that a survey be made of current research and development activities in the cartographic field. It was generally agreed that such information would be helpful to the many organizations and individuals who seek to improve their methods and materials through development work. Such efforts are not usually coordinated with the community agenda as a whole because of the lack of systematized information on current activities. It is hoped that the Committee's report may serve to minimize duplications of effort, and thus extend accomplishments in the field at large.

Because of the varied applications of the term *cartography*, the following definition was employed by the Committee, in order to confine the investigation to a specific part of this very broad field:

Compilation of essentially new maps from existing basic data, and processing of maps in general through final drafting and photo-process stages preparatory to reproduction. (This does not include the production of original data from aerial photography and field surveys.)

By the circulation of preliminary drafts, the assistance of all those known to be active in cartographic research-development was solicited, and we wish to express our appreciation for the helpful information and pertinent suggestions that were received. A few items of significance may have been omitted because of the patentable nature of some developments, the occasional desire to keep a project confidential until results have been proved, or because of security classification and the attendant clearance routine.

In order to hold the report to a reasonable size for publication, only a brief description of each item and the name of the agency or firm principally concerned with its development are presented. Those who desire further details may get in touch with the organization indicated. The agencies most frequently referred to are coded as follows:

ACIS: Aeronautical Chart and Information Service
C&GS: Coast and Geodetic Survey
ERDL: Engineer Research and Development Laboratories
FS: Forest Service
GS: Geological Survey
JASB: British Joint Advisory Survey Board
SS: Soil Survey

The Committee will appreciate any supplemental information that those reviewing this initial report may have to offer. By this means a more complete report can be published next year, and perhaps arrangements may be made for continuous maintenance of the list, publishing it from time to time when significant changes have accrued. We believe this would be a very substantial service to all those concerned with cartographic research and development, and might well be made a permanent item on the agenda of future committees. It is hoped that this first report—which must be considered a preliminary effort—will serve the purposes intended.

GILBERT G. LORENZ
LIONEL C. MOORE
SAMUEL SACHS
C. F. FUECHSEL, *Chairman*

Current Research-Development Activities

INSTRUMENTS

1. *Beam compass*—A magnesium bar for plotting long dimensions with precision is under production by Alteneder.

2. *Coordinate plotter* (produced by Fairchild).—Plots with accuracy of 0.001″. Used by GS for constructing projections and plotting control points.

3. *Coordinatograph* (produced by Henry Wild Co.).—Plotting area 1 meter with accuracy of 0.1 mm. Designed for use with photogrammetric precision plotting instruments.

4. *Drafting pens:*

(*a*) Pen of capillary design tested by JASB—was found unsuited for fine-line work but good for heavy lines such as map borders.

(*b*) At request of ERDL, Alteneder and Sons, and Keuffel and Esser have produced an improved contour pen.

(*c*) Modified LeRoy pen developed by GS for building symbols. Muth Co. is arranging for commercial production.

(*d*) Fountain pen for drafting contours is being developed by Esterbrook at suggestion of GS.

5. *Edge joining*—A frame for rectifying junctions, and matching edges on glass negatives, has been developed by C&GS.

6. *Engraving tools:*

(*a*) Rigid, swivel, fine-line, subdivider, and building glass engraving tools have recently been improved in design by C&GS.

(*b*) A portable engraving device for letters and symbols has been developed by SS. The machine affords ready enlargement or reduction of characters and is similar to a larger stationary model used and developed by C&GS.

7. *Glass beveling machine*—A grinder for beveling edges and rounding corners of glass negatives has been developed by C&GS.

8. *Glass scales*—Glass scales, 22 to 50 mm. in length with various intervals, having an over-all accuracy of 0.01 mm. are available from Henry Wild Co.

9. *Map Sketchmaster*—A device affording reduction ratios as high as 10 to 1 has been developed by GS.

10. *Measuring magnifiers*—Simple and aplanatic magnifiers with 9× magnification, as well as achromatic precision magnifiers with 12× magnification are combined with a 0.1 mm. interval, 10 mm. scale. Available from Henry Wild Co.

11. *Meter bar*—A 125 cm. dial gage meter bar made of invar for beam compass measurements, with an accuracy of 0.002 mm. has been developed by Reed Research, 1048 Potomac Street NW., Wash., D. C.

12. *Micro-rule—Starrett caliper*—Device for using beam compass points on a micro-rule, and to utilize the standard Starrett caliper vernier scale with beam points, is being developed by GS.

13. *Parallel line gage*—Transparent, micrometer-adjustment gage, with range from 0.001″ to 0.25″, has been developed by American Automobile Association, Wash., D. C.

14. *Portable projector*, auto-focusing, weighing approximately 50 lbs., has been developed for GS field parties by Reed Research. Machine affords 1/3 to 1-1/2 ratios, with resolution of detail and brightness of image comparable to larger machines.

15. *Projector* (suitable for mobile units).—A reflecting type with automatic focus, has been developed by ERDL. Machine weighs approx. 385 lbs., and affords 1/3 to 3 ratios.

16. *Projection template*—A grooved plate to facilitate construction of topographic map projections has been developed by GS. Using a Micro-rule with the template, a 7½-minute projection can be constructed more rapidly than heretofore. Accuracy equivalent to the old-style direct plotting plates.

17. *Ruling machine*, developed by C&GS, rules parallel, perpendicular, or curved lines with high precision. It can also be used to plot points with an accuracy of 0.03 mm.

18. *Ruling device*—Ink line ruling device for use with straightedge to facilitate the making of projection and grid lines, is being developed by Alteneder at suggestion of GS.

19. *Template punch*—Experimental model of an automatic, spring-loaded, needle-punch for pricking radial line intersections in paper or metal template assemblies has been developed by GS. Device eliminates inserting pins in studs and tapping them down with a hammer.

DRAFTING MATERIALS

1. *CR-39*—GS is using, experimentally, a plastic, developed by Pittsburgh Plate Glass as a glass substitute, to evaluate certain aspects of engraving versus drafting. By reducing shipping risk, the material makes "glass" engraving feasible in field offices. GS will soon report fully on the project.

2. *Drafting surfaces:*

(*a*) ERDL have under development paper aluminum foil and paper glass-cloth laminates.

(*b*) GS is experimenting with a heat-pressure process as a means of improving the surface of blue-line drafting boards.

(*c*) ERDL has conducted tests on the stability and drafting characteristics of commercially available translucent and opaque materials. Tests include paper, foil laminate,

lacquer, coated aluminum, glass cloth, plastics, and other mediums.

(*d*) Tracing cloth—"Brutex," developed by Bruning, is a new velvet matte finish cloth that is also suitable for inking. It has good transparency and has been treated for moisture resistance.

(*e*) Tracing paper—"Placene" developed by Bruning is a new synthetic resin paper, with good transparency and strength, for pencil and inking.

3. *Enamels*—JASB tests show Fox and Sons enamels and those pre-treated with the Cromak process are superior to most enamels now in use.

4. JASB is conducting tests with:

(*a*) Polythene film as a protective backing

(*b*) Polythene as a coating for maps

(*c*) Nuron laminated glass cloth

(*d*) Nuron resin-impregnated maps

(*e*) Glass Kraft paper

(*f*) Substitute for Duraseal named "Claritex"

(*g*) Vinyl film map surface bonded by adhesive heat pressure

(*h*) Woven glass cloth as a substitute for aluminum foil.

5. *Map coatings*—Investigations by ERDL on the use of plastic spray coatings for drafting mediums and maps indicate very little improvement in dimensional stability from this source.

6. *Mounted paper:*

(*a*) Thin, high-strength, tempered aluminum alloy sheets and foil-mounted "Pagra" are being tested by GS.

(*b*) Production run of vinyl-mounted multiplex paper will be made by Bakelite Corp. for the GS.

(*c*) Report on the stability properties of vinyl-mounted drafting papers has been made by GS.

7. *Plastics*—JASB has compiled a report on dimensional stability of certain plastics. Tests indicate Astrafoil (same as German Astralon), Geon, and ARL Laminate have best characteristics. Astralon was found to be the best material available for certain types of drafting and photomechanical work.

8. *Plastic coating for scribing*—Fostercote, a solution developed by ACIS, has been used for engraving copy on plastic sheets. Preliminary tests indicate a saving over conventional drafting procedure. (*See* item 2 above.)

9. *Static eliminator:*

(*a*) Antistatic compounds Nos. 79 and 79-OL, manufactured by Merix Chemical Co., Chicago, Ill., for use on plastic drafting material are now being used by ACIS.

(*b*) Copyrite Static Eliminator, a fluid for use on plastics, has been developed by N. Teitelbaum and Sons.

10. *Waterproof papers*—Report on the dimensional stability of photographic papers for processing and subsequent use has been made by JASB.

11. *Wet resisting papers*—Report on characteristics of Pergaloid, Dickinson, Cowan, Towgood, Hollingworth, and Joynson papers has been made by JASB.

DRAFTING INKS

1. *Cleaning fluid*—"Copyrite Cleaner #10" removes ink from plastic surfaces—for corrections and sheet salvage—has been developed by Teitelbaum.

2. *Low freezing waterproof ink* (black) has been developed by ERDL in conjunction with F. Weber Company.

3. *Plastic ink:*

(*a*) Ink for use on plastics on which photo images have been processed was developed by the Government Printing Office at request of GS. The ink is available in green, formula No. 53841; brown, 53840; black, 53838; and red, 53842.

(*b*) Ink suitable for covering large areas such as woodland and water tints has been developed by GS. It gives a dull black surface of good photographic value and does not chip.

4. *Watson's waterproof ink* has been found by JASB to be best for enameled surfaces.

MAP LETTERING

1. *Bruning Copyflex* is being investigated by GS as a means of producing prints from ATF Hadego film copy.

2. *Glass negatives*—A wet-plate strip film, used in place of hand engraving for correcting names and symbols, has been developed by C&GS.

3. *Lithotype*—A small composite machine, produced by Fairchild, has been investigated by ERDL.

4. *Photolettering machines*—Investigations have been made of the following:

(*a*) Barr & Stroud "Photonymograph" by JASB.

(*b*) Monotype Corp. "Monotype" by JASB.

(*c*) Westover "Rotofoto" by JASB.

(*d*) Linotype Corp. "Lino-film" by C&GS.

(*e*) Filmotype Corp. "Filmotype" by C&GS.

(*f*) Multiad Services Inc. "Headliner" by C&GS.

(*g*) ATF "Hadego" by GS and ERDL.

(*h*) Intertype Corp. "Fotosetter" by ERDL and GS.

(The 1951 Edition of *Penroses Annual* describes the following photolettering machines: Monotype, Rotofoto, Hadego, Lino-film, Headliner, Photosetter, and Higonnet.)

5. *Plastic film*—A vinylite elastic film, produced by Union Carbide and Dupont, has been used for type impressions by CIA and GS.

6. *Stripping film*—Development of a suitable film for photolettering machines is being investigated by GS, et al.

7. *Type style*—Redesign of several characters in the Paragon series was made by ATF for GS. Hadego fonts, simulating GS engraved styles are also being made.

8. *Type impressions*—A small standard hand press has been converted by SS for printing map lettering by offset.

9. *Wrico*—A new set is being distributed by Bruning who claims that it eliminates some of the objections found in other sets.

PHOTO-PROCESS

1. *Color-Eye*—A device for measurement, comparison, and standardization of map printing colors has been investigated by GS et al. Valuable to textile industry but only of indirect help in map printing.

2. *Color proofs:*

(*a*) Proof made directly from negatives or positives without the use of plates, inks, or press has been developed for use on foil by GS and on plastic sheets by C&GS.

(*b*) Process for proving of charts in color by a method similar to decalcomania has been developed by Consolidated Hammer Corp., St. Louis, Mo.

(*c*) The C&GS technique of proofing on plastics is being applied to soil maps by SS. Experiments are being made to produce proofs in 63 color patterns with 2 line colors and 9 screen and solid tints.

(*d*) Ansco, now well known, is still used, but less extensively than during the war.

3. *Color separations:*

(*a*) Technique was developed by SS for preparing finished color separations by reproducing a reversed positive of manuscript on glass.

(*b*) The "Hersol" process, conceived in Germany, has been developed by Army Map Service for producing separate negatives from a multicolor original by direct contact. In this process every color but the one desired (including black) is eliminated. Aero Service Corp. is also developing a similar process.

4. *Composites* — Photo-composite tonal prints developed by various agencies to eliminate press plate proofs, are now used extensively for final checking of topographic maps.

5. ERDL has developed a 22″ × 29″, spirit type, hand operated, duplicating machine, a 42″ ammonia process printer-developer, and has under development an improved light source for photolithographic processes.

6. ERDL is developing new equipment, methods, and materials to simplify and improve lithographic reproduction by mobile field units. The following items are now in process of development in suitable dimensions and weights for mobile use: darkroom camera, rotary offset press, paper butter, diazotype materials and process equipment, mobile map reproduction trains, and a photolettering machine.

7. *Interposing films*—40″ × 50″ in size, for preparing combination line and half tone press plates is being used by C&GS et al.

8. JASB have under consideration the development of:

(*a*) Electronic device for color control and register.

(*b*) Micrometer measuring device for plates and negatives.

9. *Light source*—Several new designs in are lamps have been noted. Graphare, Macbeth, and others now produce lamps with parabolic reflectors and automatic intensity regulators. C&GS, SS, and GS find them faster and more efficient than old designs.

10. *Negatives:*

(*a*) Process for making a direct duplicate without an intermediate stage is being used by C&GS.

(*b*) Simplified technique of preparing "window pane" negatives without opaquing has been developed by SS for reproducing single-color overlays, such as vegetation types.

11. *Pergoloid paper*—A comprehensive report of printing tests conducted on "Pergaloid 117G.S.M. and 87G.S.M." was compiled by JASB.

12. *Presensitized lithographic plates* are being developed and manufactured by Minnesota Mining & Mfg. Co., Ditto Inc., K&E, and S. D. Warren Co.

13. *Process* for the transfer of printed images from paper to vinylite has been developed by the Wilson Camera Corp., Havertown, Pa.

14. *Reflex plates* for map reproduction are being investigated by JASB.

15. *Synthetic sensitizers* are being investigated by JASB.

MISCELLANEOUS

1. *Compass*—Assembly for rapid change of magnetic declination, direct to plate, has been developed by C&GS.

2. *Craftint V-Film*—Experiments being conducted by GS.

3. *Gradients*—An economical and accurate method of preparing gradients on aeronautical charts has been developed by C&GS.

4. *Information circular* on topographic maps was prepared for public distribution by GS.

5. *Map symbol*—standardization compiled through effort of government map making agencies.

6. *Style and format sheet* prepared by GS for Federal civilian mapping agencies.

7. *Technical journals*—List of journals and associations undertaking research has been compiled by JASB.

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The Third National Surveying Teacher's Conference

The Third National Surveying Teacher's Conference, sponsored by Committee 8, Surveying and Mapping, of the Civil Engineering Division of the American Society for Engineering Education and the University of Illinois, will he held at Camp Rabideau, the University of Illinois Summer Surveying Camp, during the period August 3–8, 1952.

Like its eminent predecessors, the Rainy Lake Conference of 1937 at the Iowa State Camp and the 1940 Conference at the Case Institute of Technology Camp, the forthcoming meeting will provide an appropriate setting in which many of the topics embraced by, and some of the problems associated with, the teaching of surveying in the professional engineering colleges can be discussed. The 5-day program will stress effective pedagogy through its analysis of classroom and field techniques, its appraisal of teaching materials, and the study of course content. It will also be concerned with graduate instruction, current research, photogrammetry, summer surveying camps, the place of surveying in engineering education, and surveying in engineering practice.

Camp Rabideau, whose seventh session for undergraduate civil engineering students at the University of Illinois will close just prior to the opening of this conference, is situated in the Chippewa National Forest in the north-central region of Minnesota. It is located approximately 35 miles northeast of the city of Bemidji and some 6 miles south of the village of Blackduck, which is served by a line of the Northern Pacific Railroad originating at Minneapolis. Good roads converge upon this area from all directions.

The University of Illinois camp occupies the site of a former CCC camp. Its physical plant consists of some 18 frame buildings which have provided accommodations for as many as 115 students and staff in a single instructional period. A forest cover of scenic young birch surrounds the immediate vicinity of the camp, and three excellent lakes are within a few minutes walk of the quadrangle.

Attendance at the conference is not limited to teachers of surveying. Anyone with a strong interest in furthering surveying education is welcome. Those who plan to attend are requested to communicate at an early date with either Brother B. Austin Barry, F.S.C., Chairman, Committee 8, Civil Engineering Division, ASEE, Manhattan College, New York 71, N. Y., or Prof. Milton O. Schmidt, Director, University of Illinois Summer Surveying Camp, Surveying Building, Urbana, Ill. Information as to whether the delegate expects to bring members of his family is essential.

—Milton O. Schmidt

Map Control by Photo-trig and Subtense Bar

By EMMETT J. COON

U. S. GEOLOGICAL SURVEY, DENVER, COLORADO

THE HIGH COST of supplemental control for topographic mapping is a problem for which mapmakers are perennially seeking a better solution; it has been approached from many angles with varying measures of success. This paper describes two methods which have been explored recently by the U. S. Geological Survey. One, the photo-trig method, is directed toward the establishment of vertical control, and the second, the subtense-bar method, is concerned with establishing horizontal control.

PHOTO–TRIG

Photo-trig is a coined word, taken from the words "photogrammetry" and "trigonometry," to describe trigonometric leveling using distances established by means of photogrammetry. In other words, it is a method whereby elevations are determined through the use of photogrammetric distances, scaled in the office, and vertical angles measured in the field.

I doubt if anyone knows how long vertical angles have been used in connection with topographic mapping. We do know that in the early days of the Topographic Division of the U. S. Geological Survey most of the elevations were determined by means of vertical angles. In fact, a good many 30-minute quadrangles in those days were mapped almost entirely by plane-table intersection methods. Most of the elevations were determined by vertical angles to intersected positions. The old-time topographer was, indeed, a master in the use of vertical angles. Since the advent of photogrammetry, vertical angles have been used less and less by the Topographic Division. Using conventional photogrammetric methods, elevations are established before the map is compiled and there is no way, at that time, to scale distances in the field for use with the vertical angles. Topographers have not liked to depend on vertical angles, because without the scaled distances they cannot compute differences of elevation from the vertical angles and so check the results of their work while they are still in the locality.

The photo-trig method has been experimented with and used, to a limited extent, for a long period of time, both in this country and in Europe. In the Rocky Mountain Region, we first used the system in the mountainous part of the Camp Carson Project, Colorado, during the summer of 1947. This was on the eastern slope of Pikes Peak and the procedure was limited to a small percentage of the total control. When the job was compiled the following winter, it was proved that satisfactory checks on the elevations could be obtained when the field work and the photo-identification were done correctly.

In the spring of 1948, this method was used on the Colorado-Vanadium project in southwestern Colorado, where we were experimenting with the use of the helicopter for transportation of field engineers. This was where it was shown without doubt that the combination of the photo-trig method and the use of helicopters in connection with executing control surveys was feasible and practical. In one day, two engineers using one helicopter established 16 photo-trig points in heavy canyon country where there were no roads suitable for ground travel. This job was compiled successfully, and field-completion tests proved that the resulting map met the National Map Accuracy requirements. In the summer of 1949, all supplemental control was established by

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photo-trig in an entire quadrangle in the Vernal area, Utah. Credit should be given here to the engineers who worked on these experimental projects. Without their interest, cooperation, and accurate field work, the method might not have been considered worthy of further use.

The photo-trig method is now being used on all projects in the Rocky Mountain Region where the conditions of terrain and cover warrant its use. It is especially applicable in rugged open terrain. However, it can often be used to a limited extent in rough, timbered, and brush-covered areas where there are scattered openings. Our practice in the Rocky Mountain Region is to establish vertical-angle elevations in connection with triangulation wherever the relief is sufficient. This establishes elevations on the highest and most easily seen points, thus enabling us to use photo-trig to a greater extent.

The general procedure followed by an engineer in establishing a photo-trig elevation is as follows: First, he plans a route of approach by studying the photos with a stereoscope. On arrival, he checks his identification of the point, and determines what known elevations or control points are visible from there. He then occupies the point with a theodolite, reading a set of vertical angles, usually to at least two known elevations. After a time lapse, while he makes an identification sketch on the back of the photo, he reads a second set of vertical angles. This set should agree with the first set within about 12 seconds of arc. Our present instructions suggest that a set of horizontal angles should be read also to provide an additional check on the photo-identification. At the end of a particular project, the photos, with all necessary data recorded on them, are sent to the region office where the map is to be compiled.

During the photogrammetric compilation, as each strip of photos is scaled to fit the horizontal control, the necessary distances are scaled between the photo-trig points and the known control stations sighted from them. This enables the compiler to compute the elevations. If some of the control elevations sighted fall outside of the manuscript, the inter-station distances may be computed by an inverse solution between the geodetic position of the control point and the scaled position of the photo-trig point.

The accuracy of photo-trig elevations depends on the following factors:

1. Accuracy of the observed vertical angles.
2. Accuracy of the inter-station distances used.
3. Number of independent elevation determinations made; that is, the number of known elevations sighted from the point.
4. Accuracy of the photo-identification.

With an angular accuracy of 12 seconds, a distance accuracy of 20 feet, and the size of the vertical angles limited to 5 degrees, elevations that are within 2 feet of the true elevation can usually be established.

The photo-trig principle may be applied in another way. If simultaneous reciprocal vertical angles are read between identified photo images, a more accurate difference of elevation may be established. If a series of courses are evaluated in this manner and closed on primary elevations, the resulting control is usually very good. For example, in February 1950, we ran several miles of this sort of leveling as an experiment in the vicinity of Colorado Springs, Colo. One line, 34 miles long with the courses limited to 3 miles in length, closed within 0.6 foot. Another run of the same length with some courses in it as long as 5 miles closed within 1.25 feet. These results encouraged us to use this method on some of our later projects where suitable field conditions existed.

We are pleased with the success of photo-trig. The results obtained have shown that if the field work is done carefully and recorded accurately, satisfactory results can be obtained. The engineers who make the best use of this method are those who plan their work carefully while visualizing the control situation, and grasp every opportunity

presented for the application of known engineering principles in establishing control elevations by means of vertical angles. An alert engineer recognizes quickly the best method to use. However, photo-trig is not applicable to all conditions and should not be used when some other well-established procedure is more efficient.

SUBTENSE-BAR BASE TRAVERSE

In the subtense-base method, the lengths of traverse courses are determined by measuring carefully the angle subtended by accurately measured bases which are chained at right angles to the courses. Aero Service Corporation has used the subtense-base method quite extensively in its operations; it has also been used in various ways by several other mapping organizations. It is generally conceded that the bases should be measured to twice the accuracy wanted for the course distances. In other words, if a traverse is to be of 1 to 5,000 accuracy, the bases should be measured to an accuracy of 1 to 10,000.

Although we have had reasonable success with subtense-base measurements, some difficulties were encountered under adverse field conditions. For instance, when the terrain was rough and covered with vegetation, such as sagebrush, it was difficult to tape on the ground. When bucks were used to raise the tape above the vegetation, we found that relatively light winds vibrated the tape and hampered our progress. Bright sunlight made it difficult to obtain an accurate temperature of the tape. During the middle of the day, when heat waves were prevalent, we found that most of the signals were difficult to point on accurately. To overcome the above-mentioned difficulties, it was suggested that the bases might be measured with a subtense bar instead of a tape, and that a signal light of some kind might present a more definite object to sight on.

We knew that traverse of 1 to 5,000 accuracy had already consistently been measured with the subtense bar at sight distances of 500 to 600 feet when the subtended angles were measured with a 1-second theodolite. We had not heard of it being used for 1 to 10,000 measurements, so it was decided to try the idea on an accurately taped course.

The course we used was 900 feet long, taped to an accuracy of 1 to 50,000. Numerous runs with 2-meter subtense bars and 1-second theodolites were made over this course. The successful runs consisted of a series of short courses or sights of not more than 150 feet between the instrument and the bar. Each sight consisted in reading three sets of angles (direct and reverse) between the targets at the ends of the bar. Over 90 percent of these runs were within 1 to 10,000 of the mean of all runs. Their average was 0.06 foot less than the taped distance, but the small variation from the true distance was not considered important. We did consider it important, however, that results relatively consistent within the desired accuracy could be obtained with the subtense bar; from these results, an adequate correction factor could be computed to be applied to the subtense-bar results.

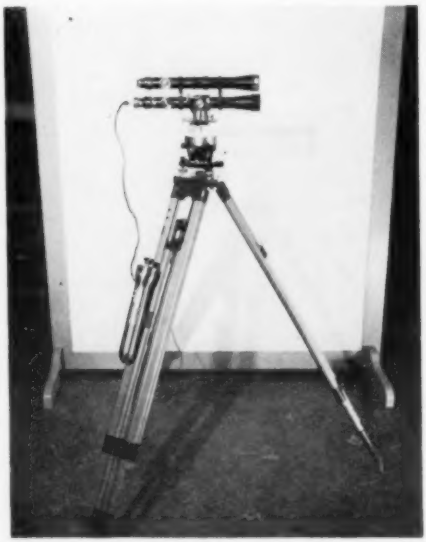

FIGURE 1.—Signal light built from two reclaimed alidade telescopes.

The few trial courses that were run using sights longer than 150 feet produced results that were not consistently within the desired accuracy.

These tests indicated that the subtense bar could be used to measure the bases for the subtense base method if distances, expanded directly from the bar, were limited to 150 feet; therefore, we decided to use it on some of the work we are doing in Wyoming.

The new signal lights for use with the subtense-bar method we think were developed from an idea conceived in the Rocky Mountain Region. These lights can be best described by referring to figure 1, which shows a signal light that was built from two reclaimed alidade telescopes. The lower telescope which carries the light is focused at infinity so that the light from the flashlight bulb at the eyepiece end is projected in a beam of parallel rays. The upper telescope, with both lenses in place, is mounted and adjusted parallel to the light beam and serves to point the signal light at the observing station.

Figure 2 shows similar signal lights of more compact design mounted on Wild T-2 theodolites. The instruments may be reversed with the lights mounted on them. These lights when focused and ad-

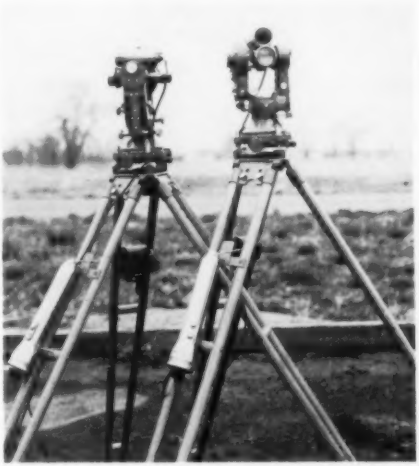

FIGURE 2.—Signal lights of compact design mounted on Wild T-2 theodolite.

FIGURE 3.—Two-meter subtense bar.

justed properly can be seen up to a distance of 10 miles in bright sunlight.

Each subtense-base party has two 2-meter subtense bars, one of which is illustrated in figure 3. It is shown guyed with light detachable cables to prevent the instrument from being blown over by the wind when left unattended. The bar is leveled by means of a spot bubble, and is oriented at right angles to the line from the observing instrument by means of a small telescope. The lights, theodolites, and the subtense bar are all interchangeable on the tripods shown.

Figure 4 shows the base-to-course arrangement used wherever the terrain will permit. The solid horizontal lines at the bottom of the diagram connecting the small triangles represent the courses between stations. The bases which are measured with the subtense bar at right angles to the courses are represented by the distances between the vertices of the two isosceles triangles extending vertically from each station. In each case the base of the isosceles triangles represents the position of the subtense bar. The distance from the theodolite at one of the stations of the course to the bar is limited to 150 feet. The lengths of the bases are exaggerated in this diagram; they are actually 1/20 of the length of the courses. The course lengths between traverse stations are determined by measuring the angles subtended by the bases from both ends of the courses. The angles (horizontal and vertical) are read with 1-second theodolites; the vertical angles are read simultaneously. All angle observations are synchronized through the use of two-way radio. The base at the forward station is measured while the rear observing party is moving to the next forward station; thus, progress is by two observing parties leapfrogging past each other.

Figure 5 shows how a base longer than 300 feet is measured. Points A, B, and C are the instrument stations and the short horizontal lines forming triangles with A, B, and C represent the positions of the subtense bar. The instrument stations and subtense-bar positions are previously set by stadia in a straight line.

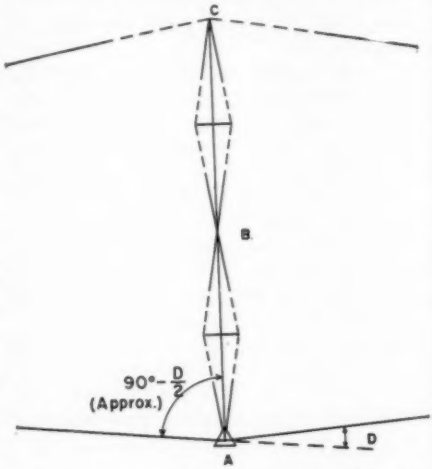

FIGURE 5.—Measuring a longer base with subtense bars.

Where the terrain does not permit a base to be laid out at every station, the overlapping base method illustrated in

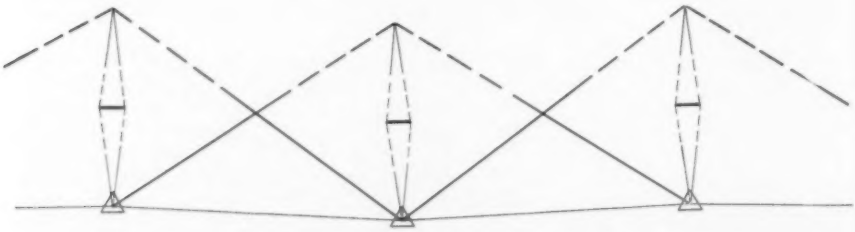

FIGURE 4.—Subtense-base traverse with subtense bar at every station.

figure 6 is resorted to. In effect, this is measuring two bases at each alternate station instead of one at each station.

We are now using a base-to-course ratio of 1 to 20. In the future we may reduce this ratio if results are consistently well within third order. So far the checks on individual courses have been excellent, and we have been able to carry elevations at least 15 miles within 1-foot accuracy. This method is believed to be definitely applicable to rolling plains country where there are few roads.

Triangulation remains the most feasible method for establishing horizontal control in mountainous terrain, and transit traverse, using a tape, is probably still the accepted method in flat, well-cultured regions.

We are looking forward to the day when improvements in surveying techniques will come more easily and more rapidly. In the meantime, let us continue to be constantly on the alert, through study, research, and meetings such as this, for means of improving our mapping methods.

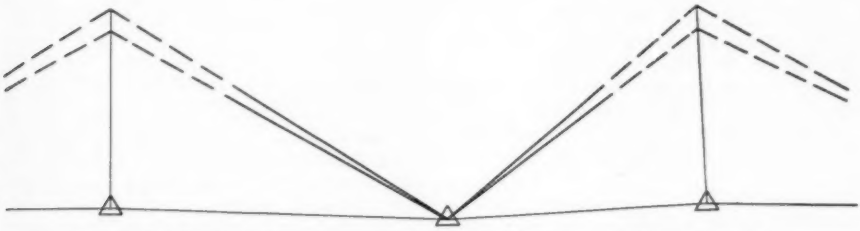

FIGURE 6.—Subtense-base traverse with overlapping bases at alternate stations.

Comments

By BENNETT G. JONES
U. S. COAST AND GEODETIC SURVEY

MR. COON'S DISCUSSION of photo-trig methods used in the Rocky Mountain Region is most interesting to me, because the Coast and Geodetic Survey began using similar methods at about the same time (1947) for the establishment of vertical control for topographic mapping with nine-lens photographs in western Alaska.

For several years the Coast and Geodetic Survey has been engaged in the preparation of topographic maps of the coastline of western Alaska from Bristol Bay to Cape Beaufort. This work is being done with nine-lens photographs and the maps are compiled at a scale of 1:20,000 with a contour interval of 50 feet. The Reading plotting instruments require a spacing of vertical control for this work such that no part of the area is more than 3 miles from either tidal shoreline or a point of known elevation. Thus, elevations must be established at 5- or 6-mile intervals throughout the area to be mapped with the exception that none need be placed immediately along the shore. Our photogrammetric field survey parties usually work in conjunction with the geodetic parties or immediately behind those parties. Elevations are carried through the main-scheme triangulation by means of reciprocal vertical angles with frequent ties to sea level. Thus, the main-scheme triangulation provides the basic control for establishing numerous additional elevations by photo-trig methods.

Photo-trig elevations are established by both resection and intersection methods, using a 1-second Wild theodolite for all angle observations. Typical photo-trig points are the tops of hills or mountains, points along the shores of lakes, and stream intersections. It appears from Mr. Coon's paper that most of his photo-trig work is done by resection methods, i.e., each station is occupied and

angles observed to stations of known elevation. We also prefer this procedure, for obvious reasons, but have not always found it to be expedient. Transportation is difficult and expensive in Alaska and we have not found it practicable to occupy all stations. We occupy those stations that are particularly difficult to identify on the photographs, and those that are to be used to extend the vertical control. Many other elevations are established by intersection and are not occupied. We might term these latter "photo-trig intersection points."

When establishing photo-trig elevations by intersection methods, great care must be taken to (1) observe on the same point from two and preferably three stations of known elevation and (2) identify each intersection point exactly on the aerial photographs. This is difficult, as will be readily understood by anyone who has attempted to observe intersection stations in mountainous or hilly country. Several procedures are in use to overcome the difficulties:

(*a*) Horizontal directions are observed to each photo-trig intersection station and these directions are used in the office whenever difficulty is encountered in the office scaling and computation of elevations. The horizontal angles are plotted to determine positions for comparison with the radial plot positions whenever the computed elevations for a station fail to agree. This procedure usually shows which vertical angle is in error because of an observation made on the wrong object. The horizontal directions may be used, of course, to compute geographic positions for the stations, but they are generally plotted with a protractor.

(*b*) Last season one field party took a panorama of photographs with a "Land Camera" from each occupied station. This camera provides immediate prints of the photographs. The photographs taken from a particular station included all points observed from that station and were used by the observer to identify these observed points from his next set-up or station; thus the photographs are somewhat of a substitute for the observer's memory, and may prove to be a valuable adjunct in this work.

(*c*) Another problem in establishing photo-trig elevations by intersection methods is the exact identification of these intersection stations on aerial photographs without occupying them. When the photo-identification is particularly difficult for a station, the observer flies out the line, that is, flies over or near the station so as to see it closely and then identifies the point on the photograph after landing.

The Coast and Geodetic Survey has also used a Wild and a Zeiss photo-theodolite for the same purpose—determining vertical control for photogrammetric surveys. Horizontal photographs have even been taken from shipboard for the same purpose. Field personnel seem to prefer observed vertical angles to the horizontal photographs. All these methods increase the office work materially for the elevations depend on distances scaled from the radial plot, but they do reduce the amount of field work in an area where good weather is rare and field operations difficult.

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New Aids for Determining Azimuth

W. and L. E. Gurley, manufacturer of engineering and surveying instruments and one of our very cooperative sustaining members, has added an important feature to the 1952 edition of the Gurley Ephemeris. Supplementing this well-known, 84-page, pocket-size publication, there is now available a listing of 28 stars selected principally for their use in determining azimuth by methods similar to those used in making observations for azimuth on the sun or Polaris. The supplement, largely the work of Professor Dan Harkness, now on the Gurley staff, furnishes complete instructions and examples for using it in connection with tables contained in the main section of the Ephemeris. Practicing surveyors and engineers, instructors, and students engaged in making observations requiring its use may obtain the publication without charge by writing to W. and L. E. Gurley, Troy, New York.

Earliest Maps of Washington, D. C.

By REAR ADMIRAL LEO OTIS COLBERT
UNITED STATES COAST AND GEODETIC SURVEY

THE first official city maps of the District of Columbia deserve special attention because of their historical record of the early planning of the Nation's Capital City. Also of interest are the struggles and conflicts of the individuals responsible for developing a comprehensive plan from which has resulted one of the world's most beautiful cities.

The first four of the early city maps are:

(1) "Plan of the City intended for the Permanent Seat of the Government of the United States—Projected agreeable to the direction of the President of the United States in pursuance of an Act of Congress passed the sixteenth day of July 1790, establishing the Permanent Seat on the bank of the Potowmac," executed by Peter Charles L'Enfant in 1791. (*See* fig. 1.)

(2) "Plan of the City of Washington in the Territory of Columbia, ceded by the States of Virginia and Maryland to the United States of America, and by them established as the Seat of their Government after the year 1800," executed by Andrew Ellicott and engraved in Philadelphia in 1792. (*See* frontispiece.)

(3) "The Dermott or Tin Case Map of the City of Washington 1797–8," prepared by James R. Dermott in 1797. (*See* fig. 2.)

(4) "The King Plats of the City of Washington in the District of Columbia, 1803," produced by Nicholas King. (*See* fig. 3.).

By Act of Congress of July 16, 1790, provision was made for the selection of a site for the Federal City of the United States. Later the next year, when the selection was made and planning had been initiated, the term Federal City was officially changed to "The City of Washington in the Territory of Columbia." This name first appears on the Ellicott map of 1792.

Three commissioners were appointed on January 22, 1791, by President Washington, to take charge of the newly created territory, to supervise its survey, and to attend to the business growing out of its condemnation for public use. More than a month previous to the Commissioners taking up their work, President Washington appointed Andrew Ellicott to survey the bounds of the territory and the French engineer, Peter Charles L'Enfant, was appointed to prepare the plan of the city. The plan of Washington as designed by L'Enfant was originally referred to as "a mode of taking possession of and improving the whole district to leave to posterity a grand idea of patriotic interest which promoted it."

Preceding and during the surveys by Ellicott of the boundaries of the District of Columbia, L'Enfant was engaged in planning the future city. On the tract where the city was to arise and also adjacent to it, there existed one real and two proposed towns. Georgetown was an established community that had been in existence some 35 or 40 years and Carrollsburg and Hamburg were proposed towns.

The manuscript plan of the City of Washington, executed by L'Enfant, in 1781, was for years in the custody of the Office of Public Buildings and Grounds of the War Department. It was mounted on cloth and for preservation was coated with varnish which had rendered it quite opaque. In 1887, the original plan, dilapidated from handling and faded by age, was entrusted to the Coast

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FIGURE 1.—Section of the L'Enfant manuscript, showing the original legend, a guide to colors on the or
manuscript, and L'Enfant's notes.

and Geodetic Survey for restoration and reproduction. The faded condition of the manuscript required that work of restoration, comparison, and verification be done under special conditions of solar light reflected by mirrors and with the aid of magnifying glasses and colored screens. In places the surface was defaced by cracks. An exact tracing of the manuscript as it existed at the time it was received was carefully prepared. In the tracing no features were reproduced which were not distinguishable on the original and this accounts for breaks in some of the lines appearing on the present printed copies.

The original drawing (fig. 1) was in colors including blue, green, yellow, light red, and dark red tints used to symbolize various features. The water areas tinted blue on the original L'Enfant map had faded, but the extent of the areas remained apparent. Fifteen areas, originally shown in yellow, were proposed for division among the several States in the Union; the center of each square was intended for a suitable memorial such as the State may choose to erect to perpetuate the memory of individuals "whose achievements rendered them worthy of being invited to the attention of the youth of succeeding generations." The yellow tint had faded from the original but the areas were restored from marginal notes.

Three dull but well-defined figures were interpreted to represent areas described in the marginal notes as being set aside for use of religious denominations in erecting places of worship. These areas were colored light red to conform with the manuscript notation.

The faded green-tinted areas on the map identified "the well-improved fields" referred to in the marginal notes as green plots. These areas included lands set aside for parks and covered mainly the area now known as the Mall, adjacent areas in southwest Washington, the White House grounds, and other park areas. A dark red tint was believed to identify the buildings existing at the time on either side of the Mall.

The plan established the width of streets and provided for avenues "to connect by direct communication the separate and most distant objects." Attention was given to "passing the leading avenues over ground most favorable for prospect and convenience." Sites were established for the Congress House (Capitol), the President's House, and a monument to George Washington which was voted in 1783 by the Continental Congress. Five grand fountains were included in the plan and attention was directed to the existence within the limits of the city of twenty-five good springs of excellent water abundantly supplied in the driest season of the year.

In order to execute the L'Enfant plan, Ellicott located a true meridional line by celestial observation which passed through the area intended for the Capitol. This line was crossed with a line of latitude that was located due east and west through the same point. The meridian was given the value of zero and established as the prime meridian of the United States; the value of latitude for the point was 35° 35′ north. These lines were accurately measured and became the basis upon which the whole plan was executed.

THE ELLICOTT MAP

When the plan was nearing completion, disagreements developed between L'Enfant and the Commissioners, which resulted in L'Enfant withholding his manuscript. The plan was to be engraved in Philadelphia but L'Enfant, instead of sending his large completed manuscript, released for engraving a sketchy type plan which the engravers found unsuitable. President Washington was informed

of the situation and he at once instructed Ellicott to add to the incomplete manuscript the necessary data for preparing the engraving.

No appreciable changes were introduced by Ellicott in correcting and completing the engraver's copy. The most important additions were the names or other designations of the city streets and the numbering of the city blocks. East and west streets designated by letters, starting from East Capitol Street and the center of the Mall, extended both north and south to W Streets which then represented the northern and southern limits of the street plan. The streets running north and south were identified numerically starting with 1st Street and were numbered consecutively eastward and westward from North Capitol and South Capitol Streets. The avenues were named for the Thirteen Original States.

Three weeks elapsed from the time Ellicott started the corrections to the plan until it was completed for submission to the engravers. It is quite clearly indicated, from the time taken by Ellicott to prepare the plan for the engravers and by comparison of the engraved map with the existing manuscript prepared by L'Enfant, that Ellicott did not devise any new scheme, but filled in some of the lacking details in L'Enfant's drawing. Thus the Ellicott map became official for the city, although it only carried out L'Enfant's original design. From this drawing the first engraved map of the City of Washington was prepared.

The only major difference between the plan of the City of Washington as it exists today, and the original plan as designed by L'Enfant and carried through by Ellicott, lies in the southwestern portion. This departure from the plan was the elimination of Tiber Creek, and the creating of Potomac Park and the tidal basin area by reclaimed land from the Potomac River.

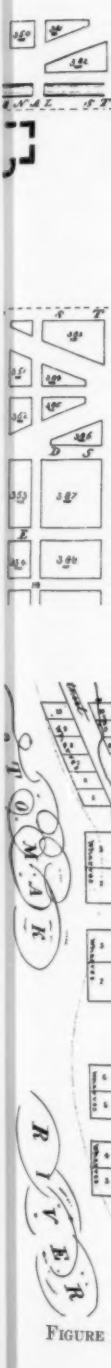
Two engraver's copies of the original manuscript were prepared by Ellicott; the first was sent to Boston for engraving and the second was assigned to an engraving firm in Philadelphia. Proofs from the Boston plate were received in Philadelphia in July 1792, and revealed that this plate did not show depths in the Potomac River and the Eastern Branch. At the request of Secretary of State Thomas Jefferson, data were immediately assembled and soundings were added to the Philadelphia engraving. This plate came into general use in the new city and was regarded as the authoritative scheme of the city.

The original copperplate, as engraved by Thackara and Vallance of Philadelphia in 1792, is now in the possession of the Coast and Geodetic Survey. Good impressions can still be pulled from this plate.

THE DERMOTT MAP

After Ellicott left the city in 1793, James R. Dermott was placed in charge of dividing the squares into lots. Prior to entering the service of the city, Dermott was an instructor at the Alexandria Academy. He was the author of the third map of the city (fig. 2), known as the Tin Case Map, which was sent to Congress in 1798 by President Adams.

Dermott was directed in 1795 by the Commissioners to prepare a plat of the city with every public appropriation plainly and distinctly delineated. Squares were sub-divided into lots in accordance with certificates of survey obtained from the office of the Commissioners. The map was intended as a part of an executive order by President Washington directing the trustees of the City of Washington to convey to the Commissioners the streets of the city and the grounds which were appropriated to public use. But in the press of business at the close of President Washington's administration the plan was not annexed to the document. To correct this omission, it became necessary in 1798 for President Adams



FIGURE

FIGURE 2.—Section of the Dermott or Tin Case Map.

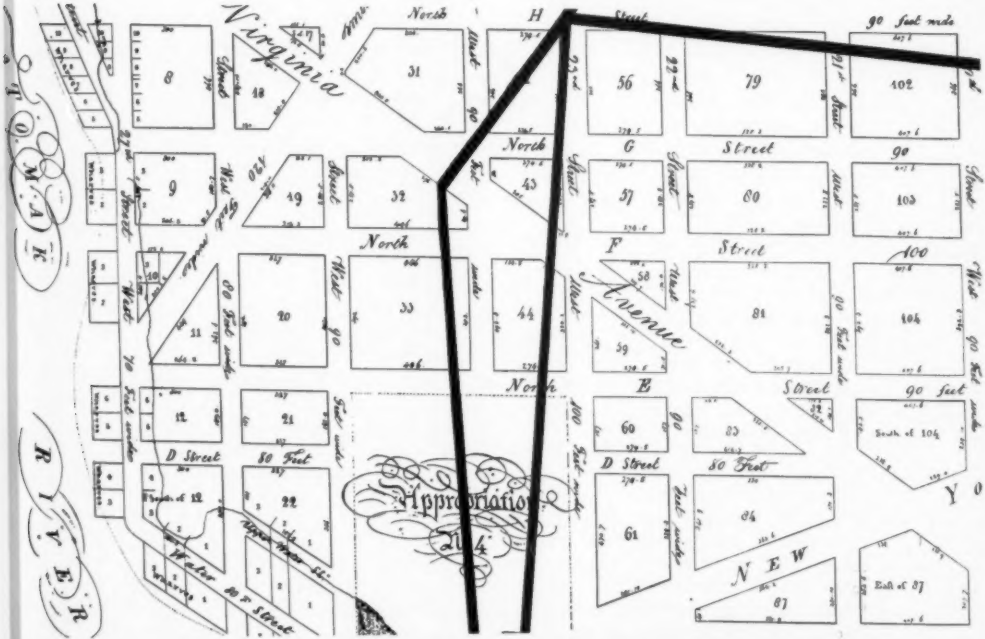


FIGURE 3.—Section of Sheet II of the King Plats of the City of Washington, produced in 1803.

to execute a second document of conveyance. Thus the map defining public lands of the new city as prescribed by George Washington was officially put in force by President Adams.

KING PLATS

The King Plats (fig. 3), completed in 1803 by Nicholas King, comprised the fourth in chronological order of the series of cartographic representations of the City of Washington. Sixteen plats, on the scale of 200 feet to the inch, are included in the series. The sheets represent an elaborate piece of map making and they were evidently prepared with great care. In addition to streets, squares, et cetera, there are indicated by red lines the holdings of the original owners of the lands within the limits of the city.

Nicholas King entered the employ of the Commissioners as a surveyor in 1796. He resigned in 1797 but re-entered on duty in 1802 as chief city surveyor. After completing the plats in 1803, Mr. King remained as the surveyor of the city until his death in 1812.

In reproducing the King Plats, careful attention was given to duplicating the sheets as nearly like the originals as possible. Nothing was touched up and no features were omitted. Blanks occurring from breaks in lines on the original drawings were left blank on the restored copy. Many errors were found in the sheets but these were reproduced just as they were found in the original plats. For instance, east was found where west should be but it was so copied, the aim being to furnish an exact duplicate of the manuscript as it appeared at the time it was copied. A careful record was kept of errors and omissions and these were noted on a sheet accompanying the plats, together with pertinent notes concerning their history.

The King Plats and Dermott map, in addition to the L'Enfant plan and Ellicott map, were required as evidence for use in court, to establish title by the Government to the flats along the Potomac River in the southwest area of the city. Like the first two manuscripts, both had deteriorated and soon would have been beyond duplication. Accordingly, the Coast and Geodetic Survey was also assigned responsibility of restoring and reproducing duplicates of these maps which were published in an atlas measuring about 28 by 41 inches. Several sets of these maps bound in Atlas form remain in custody of the Coast and Geodetic Survey.

* * *

Forty-fifth Annual Meeting Canadian Institute of Surveying and Photogrammetry

THE Canadian Institute of Surveying and Photogrammetry held its Forty-fifth Annual Meeting at Ottawa, February 6, 7, and 8, 1952. Among the many papers presented, covering various phases of the field of surveying and photogrammetry, were: "The Problem of Education for the Surveyors and Photogrammetrists of the Future" by George H. Harding, President of the American Congress on Surveying and Mapping; "Current Developments in Photogrammetry in the United States" by George D. Whitmore, President of the American Society of Photogrammetry; "Survey Control Computations" by Ronald M. Wilson, Chief, Geodetic Surveys, U. S. Geological Survey; and "Extension of Control by Photogrammetric Methods" by Lewis A. Dickerson, Chief, Photogrammetric Division, Army Map Service.

Cleveland's City Survey

By G. BROOKS EARNEST

DEAN OF ENGINEERING, FENN COLLEGE, AND CONSULTING DIRECTOR, CLEVELAND REGIONAL GEODETIC SURVEY

DURING THE PAST DECADE many of our urban areas have been expanding by leaps and bounds. In over 90 percent of our cities adequate survey operations have not been carried on to provide accurate horizontal and vertical control. In fact, most cities today lack adequate accurate control. Ernest J. Bohn, Director, Regional Association of Cleveland, a lawyer (not an engineer), recognized this shortcoming in the Cleveland region back in 1937. He did, however, seek engineering counsel with a view to rectifying this lack of basic survey data.

Mr. Bohn got the City of Cleveland, the County of Cuyahoga, and the Ohio Department of Highways to sponsor the survey project initially. The first field operations were started July 12, 1937. The crux of the success in actually getting such a project underway rested in the realization that no one public agency could afford to finance a survey of such proportions. In joint sponsorship, the total cost would be distributed among those agencies which would derive the greatest benefits from the results thereof.

Since 1937, ten additional sponsors (mostly suburban cities) have rendered financial assistance and two other sponsors have contributed by loaning first-order surveying equipment.

An Official Surveys and Mapping Committee was appointed to advise on matters of policy. The members of this committee were chosen from various public and private agencies interested in survey control, mapping surveys, and planning. This committee meets monthly, at which time the Director of the Cleveland Regional Geodetic Survey submits a report on the progress during the past month, and also the accumulative progress to date.

EXISTING CONTROL

Cleveland was devoid of accurate horizontal control. Four triangulation stations had been established in 1871 by the Lake Survey in the fringe of Cuyahoga County. Three of these were recovered and used in the triangulation net established by the Cleveland Regional Geodetic Survey. The position of one of these three Lake Survey triangulation stations was accepted as correct, and coordinates assigned in an earlier traverse control survey made by the County Sanitary Engineering Department were accepted as starting coordinates for the Cleveland horizontal control system.

The vertical control was in about the same status as the horizontal control. Monuments had been set by the Coast and Geodetic Survey initially in 1916 and, since then, additional monuments were set in 1934 and 1938, and their elevations were determined by a second-order adjustment. In 1940 the Coast and Geodetic Survey ran a precise level line between Hudson and Cleveland (about 25 miles) and the essential adjustments provided first-order mean-sea-level elevations for these monuments. Theretofore all local engineering agencies had employed a mean-lake-level datum, with a zero established at a selected elevation of Lake Erie. A final adjustment by the Coast and Geodetic Survey gave a mean-sea-level datum of 574.800 feet to Lake Erie datum, and late in 1940 both the City and the County passed ordinances adopting the new mean-sea-level datum. Since then all public and most private agencies have been employing the new datum.

INITIAL PROGRESS

The Official Surveys and Mapping Committee was first interested in a sample survey which would include all types of

control surveys and one of the end products, a planetable topographic map sheet. Accordingly, a small part of the County (approximately 56 square miles) was reconnaissanced for a triangulation net and traverse. Twenty-four triangulation stations and two base lines were observed and adjusted. Likewise, sufficient traverse was measured and adjusted to proceed with the mapping of a planetable sheet. Thus the sponsors and other interested parties were convinced of the need to continue the project through completion.

The specifications for the several orders of horizontal and vertical control and the planetable mapping were drafted to conform closely to those recommended in the American Society of Civil Engineers Manual No. 10, *Technical Procedure for City Surveys.*

VERTICAL CONTROL

The County was divided into 20 first-order level circuits, a total of 220 miles, for the initial adjustment; these circuits were further subdivided, making a total of 93 loops in the final adjustment. The average loop closure was 0.020 foot, with a maximum of 0.063 foot. These smaller loops were further subdivided by second-order level lines (levels run in one direction only) which gave a spacing of slightly less than a mile in urban areas and slightly greater than a mile in rural areas.

The first-order levels, totaling 583.91 miles, were completed in 1945. In addition, 718.62 miles of second-order levels were run and adjusted by 1945, but since then it has been necessary to run an additional 29.90 miles to provide elevations for monuments set since 1945. It is estimated that about 50 additional miles of second-order levels will have to be run to establish elevations on monuments to be set within the next 3 years to complete the vertical control.

As of January 1, 1951, 1,704 pre-cast concrete monuments have been set. Loss by construction or some other type of damage since 1937 results in a total of 1,612 official monuments remaining with integrity of elevation. In addition, all Coast and Geodetic Survey, State, County, and City monuments were included in the level lines, so that with all monuments and intermediate bench marks there exist over 3,000 points with known elevations within the County.

TRIANGULATION

The triangulation network consists of 125 stations, which involved 1 major least-squares adjustment, 1 semimajor adjustment, 4 minor adjustments, and 22 supplemental adjustments. The major adjustment included 47 stations, 5 base lines, and enveloped an area of 228 square miles. The adjacent semimajor adjustment included 17 stations, 1 base line, and enveloped an area of 92 square miles.

TRAVERSE

Official monuments, with the special C.R.G.S.[1] bronze caps, are placed in pairs, each pair about 700 feet apart. Each pair, therefore, serves the surveying profession with starting coordinates and bearing. The pairs are spaced approximately 0.6 mile apart in urban areas and 0.8 mile apart in rural areas.

A total of 610.4 miles of first-order taping, 591.8 miles of first-order angles, 267.1 miles of second-order taping, and 266.3 miles of second-order angles were observed by January 1, 1951. The field notes have been reduced and coordinate values obtained for the above-mentioned official monuments.

MAPPING

The $150,000,000 freeway program initiated by the Express Highway Committee of the Cleveland Regional Association prompted early topographic mapping by planetable methods. The scale of 1 inch = 200 feet with a 2-foot contour interval, as recommended in the American Society of Civil Engineers Manual No. 10 was used. As this mapping was needed immediately by the Ohio Department of Highways in their Cleveland Planning Office for location and line design, it was

[1] Cleveland Regional Geodetic Survey.

surveyed in strips rather than as completed sheets.

It took 6 years for four planetable parties to complete 15.66 square miles of mapping (1940–46). The State Planning Office enlarged these strip maps to 1 inch = 100 feet by means of an ideograph and precision pantograph. The location, line design, and preliminary quantity and cost estimates of the highways were based on the physical data taken from these enlargements.

A local plane rectangular coordinate system was adopted by the Official Surveys and Mapping Committee. This system had been previously established by the County Sanitary Engineers Office for planetable mapping started in the mid-twenties. The plane is tangent near the center of the County and, as the maximum county dimension is 30 miles (in the east-west direction), there is no measurable discrepancy in using this projection at the 1 inch = 200 foot scale.

AERIAL MAPPING

Time and cost figures on the planetable mapping led to consideration of photogrammetric methods. Specifications for the execution and proper performance of the proposed aerial photography and mapping were drafted. The City of Cleveland, County of Cuyahoga, and the Ohio Department of Highways entered into a cooperative agreement and the essential ordinances were passed to co-sponsor the project on an equal basis.

In October 1947 the Aero Service Corporation of Philadelphia was awarded the contract for $41,000 to:

1. Photograph the entire County on glass plate negatives at a scale of 1 inch = 400 feet (negative size 6 by 8 inches).
2. Furnish a complete set of film base contact negatives.
3. Furnish the essential photo-index maps to cover the County (25 in number, each 23 by 31 inches).
4. Furnish 1,000 reproduced four-color copies of each of eight map sheets, scale 1 inch = 200 feet with 2-foot contour interval (each map sheet = 4,000 by 5,000 feet).

The photographs were taken in April of 1948, '49, and '50. Photography was attempted in the fall of 1948 and '49, but with practically no success because of wind conditions.

Ozalid proofs of the manuscripts of the eight map sheets were submitted during the summer of 1948. Field parties were organized to check profiles, and 26.29 miles of traverse profiles were run for the eight sheets; 95.4 percent checked within 1 foot, and there was no discrepancy exceeding the full contour interval of 2.0 feet. All position checks on buildings, street intersections, edges of woods, and drainage ditches were within specifications.

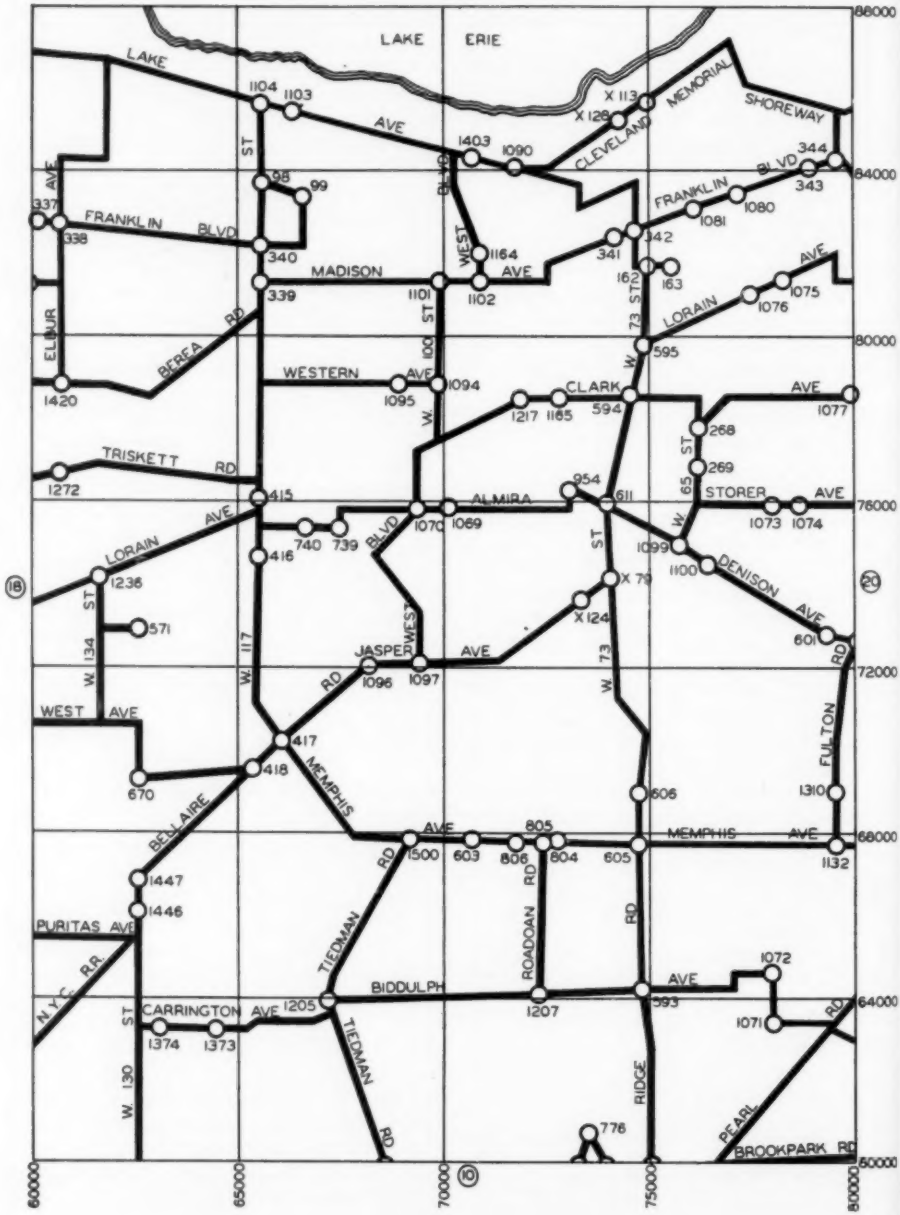
Since this original contract, there have been three additional orders for map sheets—one by the American Steel and Wire Company for two sheets, and two by the County Engineer's Office for four sheets and one sheet, respectively. Considerable interest has been displayed by both public and private agencies relative to time and cost data for mapping certain sections of the County. There are approximately 700 map sheets to cover the County, of which about 100 are partial sheets around the fringe.

The eight map sheets in the original contract were selected in an area considered for one of the freeways. They are now being used to study alternate centerline locations and comparative cost estimates.

PHOTOGRAPHY

There has been considerable demand for either contact prints or enlargements of the aerial photographs by the various cities and other governmental agencies. These are used principally for land-use planning, and other types of planning where it is desirable to have full knowledge of existing ground conditions. Several agencies have been interested in mosaics, not only to study existing ground plan conditions, but also to have a fairly accurate scale for better approximation of distances. Such mosaics are of special interest to the tax departments.

CLEVELAND REGIONAL GEODETIC SURVEY SECTION 19



FINAL PUBLICATION

The County has been divided into 31 sections for the final publication of data. Each section extends seven map sheets or 28,000 feet in a north-south direction, by four map sheets or 20,000 feet in an east-west direction. (*See* accompanying illustration.) The final publication includes the descriptions, elevations, and coordinates of all monuments and, in addition, the descriptions and elevations of intermediate bench marks. Each section is compiled in booklet form on 8½- by 11-inch mimeograph paper, with a cover sheet map upon which are outlined the map sheets, with coordinate values, level lines, monuments with their numbers, and the names of the streets on which the level lines are located. These publications were started with the central area of Cleveland and are being completed radially toward the county boundaries. As of January 1, 1951, eight sections had been completed. After all the sectional booklets have been completed, books may be compiled from them to cover a particular city or other incorporated area.

USE OF SURVEY

Many organizations, both public and private, appreciated the value of the vertical control data and began using it immediately. However, the new coordinated horizontal control system had been employed only by the County Sanitary Engineer's Office and many surveying offices were, and still are, hesitant to use it.

Mr. S. A. Bauer,[2] a Cleveland property surveyor of national repute, ran 30 miles of third-order traverse over our first- and second-order lines to compare accuracies. He obtained remarkable agreement, averaging 1 : 19,000. Since this comparison he has employed the Cleveland Regional Geodetic Survey monuments wherever possible and has run an additional 30 miles with an average agreement better than 1 : 20,000.

The Cleveland Transit System, in their $22,500,000 program for the establishment of 13 miles of rapid transit, called for ties to the Cleveland Regional Geodetic Survey monuments for all survey control. Remarkable closures were obtained by Mr. Bauer on this project.

It will only be a matter of time when all surveyors in metropolitan Cleveland will tie all surveys into the Cleveland Regional Geodetic Survey control. Once a survey point has been computed on the coordinated system, it cannot be lost as it will always be possible to replace it from other points computed on the system. Considerable missionary work and a great deal of education has been required to convince agencies and individuals of the advantage of using the survey data. The photogrammetric mapping has been very instrumental in enhancing the value of the control system and the end product, the topographic map.

[2] President of American Congress on Surveying and Mapping in 1950.

MAP-MINDED MILWAUKEE

"We need no further sales talk. Please enter a library membership for us for one year. What back numbers of SURVEYING AND MAPPING do you have available?"—Milwaukee Public Library.

We are at a loss to understand why we are accused of sales talk. In reply to Milwaukee's inquiry, we stated modestly that our Journal is "the only publication in the United States devoted 100 percent to the surveying and mapping profession, and for that reason alone every city library in the country should make an effort to bring it to the attention of that large segment of the public which makes and/or uses maps and charts."

FRANK S. BORDEN, *Chairman*
Membership Committee

Portable Reflecting Projector

By C. S. MALTBY
U. S. GEOLOGICAL SURVEY

IN field mapping operations, a reflecting projector is sometimes a very helpful aid in transferring details from aerial photographs to a map. During the past 15 years several field engineers of the Geological Survey have made workable but more or less makeshift instruments, some of which have been used extensively. Initiation of revision programs and a new policy requiring the addition of woodland to older maps has accentuated the need for a compact, lightweight, portable projector, suitable for use in field offices.

To meet this need, the Geological Survey awarded a contract to Reed Research, Inc., Washington, D. C., in June 1951, for developing and building a portable, autofocusing reflecting projector. As of November 1951, a prototype has been designed, built, and satisfactorily demonstrated, and an order has been placed for 52 projectors. General specifications are as follows: the range of the instrument is from 1 to 1.5 enlargement to 3 to 1 reduction; any 7- by 7-inch portion of copy as large as 18 by 24 inches can be enlarged or reduced; over-all dimensions are 17 inches wide, 20 inches deep, and 34 inches high; the total weight of the instrument is 52 pounds. A carrying case is provided that takes the instrument completely assembled. The contract specifies delivery in April 1952.

A unique feature of the projector is that it employs no counterweights, pulleys, chains, or cables. Operation of a single hand crank positions the lens and the copyholder automatically so that the projected image is kept in sharp focus throughout the entire range. This motion is accomplished with a simple but positive mechanical linkage. The hand crank is counterbalanced so that it turns easily; it requires less than 30 seconds to change from maximum enlargement to maximum reduction.

The projector consists of four main parts: the base and columns, the lamphouse, the lens carrier, and the autofocusing device.

BASE AND COLUMNS

The base is an aluminum casting that is fastened to a 15¾- by 20-inch projection board, which can be placed on any desk or table. There is a clear space of 10 inches between the center of the projected image and the edge of the base casting, permitting projection onto any part of an 18- by 24-inch field sheet. Fitted to the base casting are two vertical columns of polished, chrome-plated tubular steel. Six ball-bearing rollers on the lamphouse and six on the lens carriage travel on the main column, and the system is held in close alinement throughout the range of operation by ball-bearing rollers tracking on the guide column. The ground race ball bearings are lubricated for life and sealed.

LAMPHOUSE

The lamphouse, although made of lightweight sheet aluminum, is extremely rigid, and is mounted on an aluminum casting. A first-surface mirror is fastened in the center of the lamphouse to reflect the image from the copyholder downward to the lens. The copy is adequately lighted by two 150-watt standard projection bulbs, placed one on each side of the mirror. Light from the bulbs is reflected to the copy by spherical reflectors, and baffles serve both to prevent direct light from reaching the lens and to channel heat upward to the vent. The temperature rise during continuous use is not excessive.

Copy is held against a ¼-inch-thick glass plate at the front of the lamphouse. The copyholder is simple and easy to manipulate, and will hold any part of an

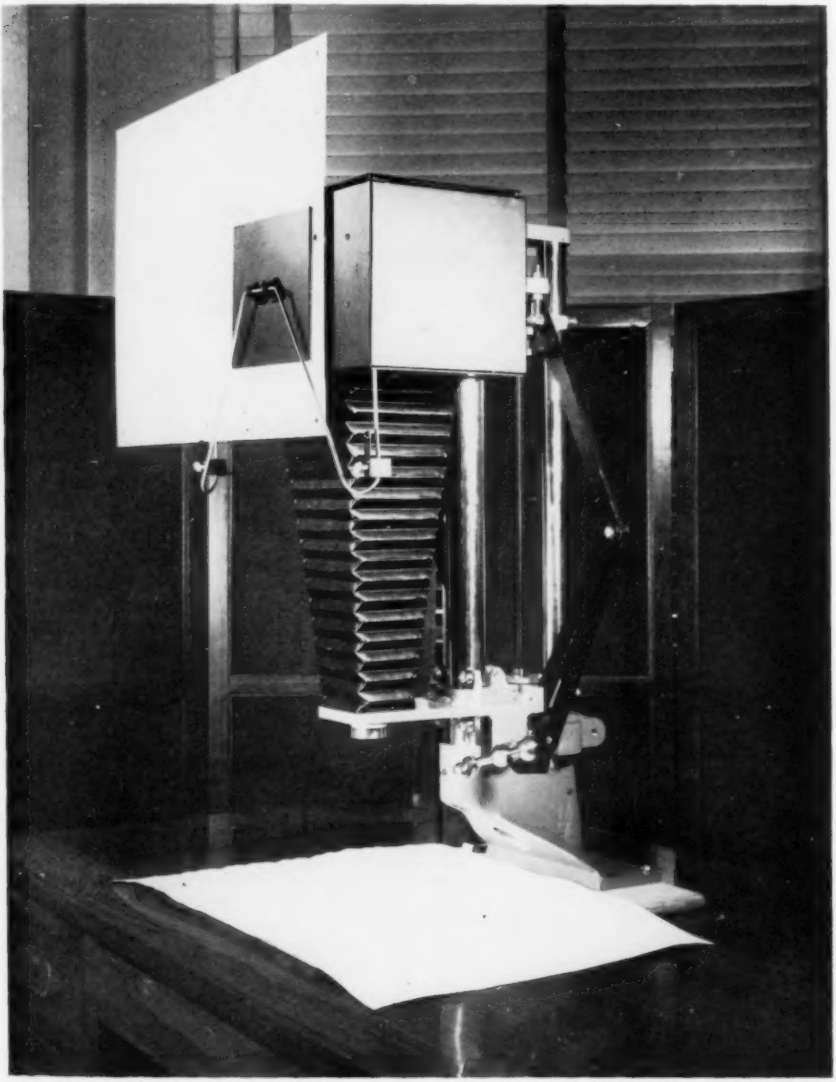
18- by 24-inch sheet in projection position. No thumb screws or latches are employed in placing or removing copy.

LENS AND CARRIER

A Wollensack Raptar projection lens is mounted in an aluminum casting. The lens has a focal length of 6-3/8 inches, and an adjustable aperture of f/4.5. The casting also carries the lead screw driving nut and the hand crank mechanism.

AUTO-FOCUSING MECHANISM

The heart of the system is a unique



Portable reflecting projector, set for maximum reduction (3 to 1), holding 18- by 24-inch copy.

parallelogram linkage that provides the geometrical solution of auto-focusing. The top end of the parallelogram is anchored to the lamphouse casting, and the bottom end to the base casting. Cross links connect the outer extremities of the parallelogram to studs on the lens carrier which is also connected to the lamphouse casting by the lead screw.

The links of the parallelogram are precisely machined, and the pivoted ends are equipped with ground race ball bearings to prevent lost motion and undue wear. The hand crank is geared to the lead screw so that turning the crank results in movement between the lamphouse and the lens carrier. This movement of one with respect to the other is the exact amount necessary to maintain sharp focus throughout the entire range of scale change from magnification to reduction. No adjustments of any kind are necessary after factory setting, unless the projected image must be focused on a plane above (or below) the base board. A simple arrangement for this change is provided.

▼ ▼ ▼

Wisconsin Surveyors' Institute

The Third Surveyors' Institute was held at the University of Wisconsin, Madison, on November 27–29, 1951. The institute was planned for the practical surveyor and the program and all discussions were directed toward helping him solve his practical problems. Some typical items on the program were:

Legal Aspects of Surveying—Arthur D. Kidder; *Why Records of All Property Surveys Should Be Filed for Public Use*—Alex W. Ely; *Engineering Curves—Methods of Computing and Staking Out*—H. A. Kallsen; *Economics of Surveying (Fair Fees for Typical Surveys)*—R. P. Boyd; *Stadia Surveying*—E. C. Wagner; *Subdividing Land for Livable Plats*—G. William Longnecker; and *Some Different and Successful Subdivisions*—W. M. Haas.

The Wisconsin Society of Land Surveys was organized at this gathering. One of the aims of the Society will be to seek legislation for the registration of all practicing surveyors, and by this means to eliminate errors in land descriptions and plats. At present anyone can practice surveying in Wisconsin.

Article II of the constitution of the Society reads, "The purpose of the organization shall be to promote the common good and welfare of members engaged in the practice of land surveying, to foster high standards of professional ethics and practice and thus encourage public faith in and reliance on land surveyors and their work, to promote the study of land surveying problems and the education of land surveyors."

The By-Laws provide that "The Society may become affiliated with organizations having similar purpose or objective upon affirmative vote of a majority of the members at an annual meeting of the Society."

The officers of the new society are: Robert M. Poss, city engineer, Marinette, *President*; Richard B. Mecha, Manitowoc, *Vice-President*; Harry A. Kallsen, civil engineering instructor, University of Wisconsin, *Secretary*; O. O. Bergman, Sparta, R. P. Boyd, Eau Claire, and Alex W. Ely, Madison, *Directors*.

The ACSM congratulates this new society and wishes it all future success in its aims and endeavors, and with respect to the By-Law quoted above hopes that the new society will see the advantage to be gained by affiliating with the ACSM.

Surveying and Mapping News

Members are requested to send in surveying and mapping news items for publication in SURVEYING AND MAPPING—EDITOR.

CURRENT SURVEYING AND MAPPING LITERATURE

MAGAZINE ARTICLES

LE GEOMETRE AUX ETATS UNIS. Oscar Messerly, *Journal des Géomètres Experts*, 10 Octobre, 1904. No. 270. (A discussion of the history and practice of land surveying in the United States for the information of French surveyors.)

LE GEOMETRE EN PALESTINE. Rene Danger, *Journal des Géomètres Experts et Topographies Français*, 110eme Année. No. 5, Mai 1949. (Comments on the position of the land surveyors in Palestine and lists regulations and standards adopted for the profession.)

KARTOGRAPHIE IN DEN U. S. A. Berthold Carlberg, *Petermann's Mitteilungen*, May 1950. (An analysis of American cartography by a German cartographer who has been connected with Justes Perthes in Gotha for many years.)

FEDERAL SURVEYS AND MAPS. J. O. Kilmartin, *The American Year Book*, 1950.

THE INTERNATIONAL MAP OF THE WORLD. Dean S. Rugg, *The Scientific Monthly*, April 1951. (Gives a report of the present status of the IMW series and outlines problems to be solved before the series can be completed.)

CONSTRUCTION OF PLASTIC TOPOGRAPHICAL RELIEF MODELS. Henri Benecker, *International Hydrographic Review*, May 1951. (Discusses both U. S. and foreign methods of producing relief models from plastics, rubber, and other mediums.)

MODERN METHODS OF NAUTICAL CHART PRODUCTION. Guillermo Medina, *International Hydrographic Review*, May 1951. (A summary of recent developments in hydrographic charting by the Navy Hydrographic Office.)

SURVEYING AND MAPPING IN THE UNION OF SOUTH AFRICA. Adrian Roberts, *The Canadian Surveyor*, July 1951. (Discusses the functions of the Trigonometrical Survey Office of the Union of South Africa.)

THE UNITED STATES COAST AND GEODETIC SURVEY: ITS WORK AND PRODUCTS. Robert F. A. Studds, *Empire Survey Review*, July and October 1951. (An illustrated discussion in two installments.)

CONTINENTAL SLOPE OFF APALACHICOLA RIVER, FLORIDA. G. F. Jordan, *Bulletin of the American Association of Petroleum Geologists*, September 1951.

ENGINEERING GEOLOGY OF SAN FRANCISCO BAY, CALIFORNIA. Parker D. Trask and Jack W. Rolston, *Bulletin of the Geological Society of America*, September 1951. (Discusses the principal engineering problems that confront the geologist in San Francisco Bay.)

GEOGRAPHY OF KANSAS, PART III, HYDROGRAPHY. Walter H. Schoewe, *Transactions of the Kansas Academy of Science*, September 1951. (A comprehensive study of rivers or streams, creeks, lakes, ponds, marshes, springs, wells, underground water, irrigation projects, precipitation such as rain or snow, etc.)

AN INSTRUMENT AND METHOD OF TEACHING CONTOUR LINES. James W. Hamilton, *The Journal of Geography*, September 1951. (Contains details for constructing a model for use in visualizing relief contours.)

SOUNDINGS ABOVE NIAGARA FALLS OBTAINED BY HELICOPTER AND KYTOONS. Frank P. Bane, *Civil Engineering*, September 1951. (Discusses the difficult problems involved in taking soundings of the Cascades just above Horseshoe Falls at Niagara.)

STUDENT MAPPING OF AN AREA OF MULTI-STORY BUILDING. Wesley Clef, *The Journal of Geography*, September 1951. (Outlines objectives of field work in elementary courses in college geography.)

UNIVERSITY TRAINING FOR GOVERNMENT CARTOGRAPHERS. Arthur H. Robinson, *The Professional Geographer*, September 1951. (An outline of the training required to qualify for cartographic work in government service.)

CALIFORNIA HIGHWAYS AND PUBLIC WORKS. September–October 1951. (This issue, the first received by ACSM, is devoted primarily to highway maintenance and development.)

CAN WE GET MORE ENGINEERS INTO

PUBLIC POSTS? N. W. Dougherty, *Civil Engineering*, October 1951.

OCEANOGRAPHY IN GENERAL EDUCATION. Aubrey Haan, *The Journal of Geography*, October 1951. (A discussion of the life and movement of oceanic waters as they affect various aspects of man's existence.)

SURVEYING AND MAPPING IN PEACE AND WAR. Gerald FitzGerald, *The Canadian Surveyor*, October 1951. (Paper presented at the Annual Meeting of the Canadian Institute of Surveying and Photogrammetry, Ottawa, February 1951.)

THEY WANT TO REBUILD SAN FRANCISCO BAY. Frank J. Taylor, *The Saturday Evening Post*, November 18, 1951. (Provides details of the Reber Plan.)

BOOKS AND PAMPHLETS

ASTRONOMY APPLIED TO LAND SURVEYING. R. Roelofs, *Ahrend & Zoon*, Amsterdam. 1950. 259 pages, 17 nomograms, 15 tables, 71 diagrams. $6.00.

THE AMERICAN OXFORD ATLAS. *Oxford University Press, Inc.*, New York. 1951. 8 pages introduction, 80 pages topographic maps, 24 pages distribution maps, 98 pages gazetteer and appendix. End pages reproduced from a map in the old Oxford Geography.

DOWN TO EARTH MAPPING FOR EVERYBODY. David Greenhood, *Holiday House*, New York. 1951. 262 pages. $5.00.

ECHO SOUNDING AT SEA. H. Galway, *Pitman Publishing Corporation*, London. 1951. 299 pages. 35s. (Recommended reading for those concerned with the installation, maintenance and operation of echo-sounding equipment.)

THE HOTCHKISS MAP COLLECTION. Clara Egli LeGear, *Map Division, The Library of Congress*, Washington. 1951. x, 67 pages, index. (A list of manuscript maps, many of the Civil War period, prepared by Maj. Jed Hotchkiss and other manuscript and annotated maps in his possession.)

LIFE OF PIERRE CHARLES L'ENFANT. H. Paul Caemmerer, *National Republic Publishing Company*, Washington. 1951. 480 pages. 114 illustrations. $10.00. (City planners will be especially interested in the maps and views of various cities.)

PETROLEUM GEOLOGY. Kenneth K. Landes, *John Wiley & Sons, Inc.*, New York. 1951. 660 pages. $10.00. (Covers techniques of petroleum geologists, geologic occurrence of petroleum, and present and future oil supplies.)

PLANE AND GEODETIC SURVEYING FOR ENGINEERS. David Clark, *Constable & Co. Ltd.*, London. 1951. 582 pages with 205 illustrations. 32s. 6d. (The fourth edition of the volume, containing descriptions of new methods developed during and since the war.)

POWELL OF THE COLORADO. William Culp Darrah, *Princeton University Press*, 1951. $6.00. (An exhaustive biography of the famous American soldier-scientist and second director of the U. S. Geological Survey.)

RAND McNALLY STANDARD WORLD ATLAS. *Rand McNally & Co.*, Chicago. 1951. 400 pages. $5.95. (A new compilation of maps and information in a handy-sized volume.)

THE SEA AROUND US. Rachel Carson, *Oxford University Press*, New York. 1951. 230 pages, illustrations, index, references. $3.50. (Deals with various aspects of the oceans on the basis of oceanographic studies as recent as 1951.)

THREE-DIMENSIONAL MAPS. Walter W. Ristow, *Map Division, The Library of Congress*, Washington. 1951. x, 40 pages, index. (An annotated list of references to the construction and use of terrain models.)

WEBSTER'S GEOGRAPHICAL DICTIONARY. *G. & C. Merriam Company*, Springfield, Mass. 1951. 1,352 pages. $8.50. (Contains over 40,000 names arranged alphabetically, with alternative names, spellings, and pronunciations of each in addition to geographic information.)

—A. A. STANLEY

DISTINCTIVE RECENT MAPS

A world map showing *Distribution of Malaria Vectors* comprises plate 3 of the "Atlas of Distribution of Diseases," being published serially by the American Geographical Society. The map sheet, measuring 25 by 38 inches, was issued as a supplement to the October 1951 issue of *The Geographical Review*. Several maps share the sheet, the largest of which shows "Species of Anopheles Extensively Distributed," at the scale of 1: 50,000,000. World "Distribution of Malaria Parasites" is mapped at the scale of 1: 100,000,000. Other insets show "Species of Anopheles Locally Distributed Over Southern Europe, the Near East, and Africa" (1: 35,000,000), and "Species of Anopheles Locally Distributed Over Southern Asia and Indonesia." Notes on the "Epidemiology of Malaria," a chart "Résumé of Natural History," and a list

of selected sources fill space on the sheet outside the projection limits of the main map. A selected bibliography on the general subject covered by the map is printed on the verso of the sheet.

Carte des Cinq Parties du Monde on Planisphère is the title of an attractive pictorial map in color prepared by Jacques de Dure, and published at Brussels (*c.*1951) by Les Editions De Visscher. It shows industries, agriculture, arts, customs, commerce, and historic landmarks. The map measures 29 by 40 inches. No scale is given.

The Zentralinstitut für Forst- und Holzwirtschaft in Hamburg-Reinbek issued, in 1951, the first four sheets of a new *Weltforstatlas*. This ambitious project is being edited by Richard Tarunsky under the direction of Dr. Franz Heske. The sheets in hand show general forest distribution in Northern Eurasia (1: 10,000,000), France (1: 2,000,000), Germany (1: 2,000,000), and Great Britain (1: 2,000,000). Names on the map proper are in German, but the text is printed in English, French, and Spanish, as well as in German. Future plates will show distribution of various species of trees, extent and location of lumber and woodworking industries, and the extent and channels of international trade in lumber. The atlas as planned will include 50 sheets, and is scheduled for completion in 1952. The cost for the full series of maps will approximate $120.00.

A new edition of the popular National Geographic map of *United States of America* was distributed as a supplement to the June 1951 issue of the *National Geographic Magazine*. Laid out on the Albers Conical Equal Area projection, the map measures 26 by 41 inches and is at the scale of 1: 5,000,000. Inset maps are entitled "East of Maine" and "New York Area." An index to the 11,025 place names on the map may be ordered from the National Geographic Society.

The Forest Service, United States Department of Agriculture, published in 1951 a new edition of its map showing *National Forests, State Forests, National Parks, National Monuments and Indian Reservations*. It is at the scale of 1: 7,000,000 and measures 18 by 29 inches. In addition to the administrative divisions mentioned in the title, the map shows forest boundaries corrected to May 1, 1951; grazing districts; and purchase units (areas within which lands are being acquired). A marginal table lists headquarters of forest regions, experiment stations, supervisors, and state foresters.

Meteorological Services in the United States shows location and types of surface-weather-reporting stations operated by the United States Weather Bureau, Civil Aeronautics Administration, Air Forces, Navy, and Coast Guard. Forecast centers, flight advisory weather service units, Weather Bureau regional headquarters, airport stations, and city offices are also identified on the map. Issued in 1951 by the Weather Bureau (W.B. Map 1806), this colored map is at the scale of 1: 5,000,000 and measures 25 by 39 inches. Fourteen small inset maps locate weather services in major U. S. cities.

The Department of Labor, U. S. Employment Service and Affiliated State Agencies, and the Farm Placement Service have collaborated to produce a map showing *Major Migratory Routes in the Agricultural Labor Market*. It contains a variety of information, including crop areas, seasonal work charts, and State employment service headquarters offices. The map, measuring 30 by 40 inches and at the approximate scale of 1: 6,000,000, is uncolored. It was published in 1951. The addition of arrows to show the movement of labor would have added to the usefulness of the map.

A map of *Natural Gas Pipe Lines in the United States* was published in 1950 by Alec M. Crowell of New Orleans (Carondelet Building). It is at the scale of 1: 7,500,000 and is printed in color. Pipe lines which are "proposed," "approved," and "under construction" are shown, as well as those actually "operating." Numbers key the pipe lines to the 118 gas companies which control them.

The Engineers Official Map, State of California, by W. Elliott Judge, shows U. S. and State highways, railroads, counties, and townships. Marginal data includes a list of the counties with their vital statistics, and an index of more than 1,700 inhabited places. Enlarged inset maps show the San Francisco and Los Angeles metropolitan areas. This large wall map, suitable for classroom use, measures 60 by 41 inches and is at the scale of 1: 800,000.

Several recent map publications of the U. S. Geological Survey are of more than general interest. Among these is the new edition of the large (53 by 41 inches) topographic map of *Washington and Vicinity* at the scale of 1: 31,680. Originally published in 1915, the map was first revised in 1942. The present revision (1951) is based on new aerial photographic and planetable surveys. Comparison of the new map with that published in 1942 emphasizes Washington's urban and suburban growth during the past decade. Extensive suburban housing developments such as Viers Mill Village and Carroll Knolls in Maryland and Jefferson Manor in Virginia are quite in evidence. Extensive urbanized areas have been added in Arlington and Fairfax Counties and the cities of Alexandria and Falls Church. The new Shirley Highway in Virginia adds another thread to the network of roadways which radiate from the city.

Another of America's large metropolitan areas is shown on the *Indianapolis and Vicinity* map, also published in 1951. Prepared in cooperation with the State of Indiana, the map measures 47 by 39 inches and is at the scale of 1: 24,000. The present map represents a consolidation of four 7½-minute quadrangles, namely, Indianapolis East, Indianapolis West, Maywood, and Beach Grove. Contours on the new map are drawn at 5-foot intervals. Urbanized areas are tinted red. Extensive new housing developments stand out in the north and west sections of the city. All four- and six-lane highways leading into the city are traced in red.

In 1951 the Geological Survey issued the following new sheets of the *International Map of the World* at the scale of 1: 1,000,000: Austin [Texas], North H-14; Mississippi Delta, North H-15; Cascade Range, North L-10. As on other sheets in this series, generalized topography is indicated by hypsometric coloring. Of the 53 projected sheets for the United States, 12 have so far been published. Work is in process on the Los Angeles and Savannah sheets, but completion of the series has now been indefinitely suspended.

Of interest to students of city planning and urban geography is the recently issued map entitled *Levittown, a Garden Community.* The map, which includes a marginal index of streets, is designed as a street guide of this extensive new real estate development on Long Island. Published by Levitt and Sons, Inc., the map measures 26 by 33 inches and is at the scale of 1: 12,000.

A new map of *Alaska,* at the scale of 1: 2,500,000, was recently published by the Kroll Map Company of Seattle. Compiled and drawn by Edwin C. Poland, it shows roads, railroads, landing facilities, glaciers, trails, spot heights, national parks, wildlife refuges, and Indian reservations. Internal judicial divisions are delimited. The Kroll map bears many resemblances to *Alaska, Map B* (1: 1,584,000) published by the Geological Survey in 1950.

Northwestern Canada, Transportation Facilities—1950, is the title of a map published recently by the Surveys and Mapping Branch, Canadian Department of Mines and Technical Surveys. It is at the scale of 1: 3,200,000 and measures 30 by 23 inches. Motor and winter tractor roads, airfields, seaplane anchorages, and radio stations are mapped. Also shown are schools, hospitals, nursing stations, trading posts, and missions. "Distances in miles by air between main centres along principal flying routes" are given in a marginal table.

The map supplement to the September 1951 issue of the *National Geographic Magazine* is entitled *Central Europe Including the Balkan States.* It measures 38 by 28 inches and is at the scale of 1: 2,500,000. Russian and Polish boundaries shown are based upon treaties and claims as of July 1, 1951. Occupation zones of Germany and Austria are clearly outlined. An index, in pamphlet form, includes 10,378 names which appear on the map.

A detailed administrative map, showing minor subdivisions and hundreds of towns and cities of Italy, was published at Milan in 1951 by the map firm of De Agostini. It is printed in color on two sheets, each measuring 39 by 55 inches. The scale is 1: 500,000.

Det Centrala Stor-Stockholm is the title of a large new four-sheet map of Stockholm published in 1951 by the Generalstabens Litografiska Anstalt. Each sheet measures 47 by 36 inches, and the scale of the map is 1: 16,000. Built-up areas; proposed developments; public buildings; parks; bus, trolley, and taxi stops; and church and political divisions are indicated. Compilation was based largely upon the 1950 map of the Stockholm city planning commission at the scale of 1: 10,000. Additional information was supplied by the governments of surrounding communities.

Two colorful and attractive maps of south Africa were published in 1950 by Art Maps Printing, Ltd. of Johannesburg. The first at the scale of 1: 1,800,000, is entitled *Cape of Good Hope.* The scale of the *Transvaal* map is 1: 1,250,000. Both maps measure 28 by 33 inches and carry the subtitle "A Guide to its Pleasure Resorts and Historic Places." Data indicated on the maps includes roads, railroads, cities, towns, economic resources, agricultural and industrial products, historic sites, and recreational areas. Illustrations of historic figures, places, and events border the maps.

Main Areas of Tea Production in Asia and east Africa are identified on a map published for the Tea Bureau in 1951 by Geographia, Ltd. The scale is approximately 1: 18,000,000 and the dimensions 19 by 29 inches. Sixteen producing areas are shown on a colored physical base map. Names of tea ports are underlined in green. Production and export figures, in millions of pounds, are included.

The status of geological surveys in New Zealand is the subject of a map published by the New Zealand Geological Survey, E. V. Paul, Government Printer, Wellington. It is entitled *New Zealand, Showing State of Systematic Geological Survey on 1st June 1951.* North and South Islands are on separate sheets, each measuring 22 by 16 inches. The scale of this colored map is 1: 1,600,000. The map appropriately indicates areas, for which surveys have been published, have been completed, are in progress, or are out of print. The index to the national grid is also given.

—WALTER W. RISTOW
—MARIE C. GOODMAN

MAP INFORMATION

This department was inaugurated for the purpose of bringing to the attention of the members information pertaining to the availability of maps, surveys, etc., with particular emphasis on how such material can be procured. Authoritative articles covering this class of information are solicited. It is believed that through an interchange and dissemination of such information maximum benefits will accrue to the surveying and mapping profession.

—EDITOR

Topographic Maps

THE FOLLOWING topographic quadrangle maps were published between September 1 and November 30, 1951, by the U. S. Geological Survey (New Publications Lists 518 through 520). All maps are available with or without the green overprint which indicates woodland. The quadrangle name is shown in capital letters, followed by the county name in upper- and lower-case letters. Since many quadrangle maps extend into several counties, only that county name is given which contains the place or feature for which the quadrangle is named. For example, the quadrangle EVA, in *Alabama*, is in parts of Morgan and Cullman counties, but only Morgan is shown because the town of Eva is in that county.

Maps of areas east of the Mississippi River may be ordered from the Chief of Distribution, U. S. Geological Survey, Washington 25, D. C., and of areas west of the Mississippi River from the Distribution Section, U. S. Geological Survey, Denver Federal Center, Denver, Colo.

Alabama
EVA—Morgan
FALKVILLE—Morgan
HARTSELLE—Morgan†
LAWRENCE COVE—Morgan
MAYSVILLE—Madison†
MERIDIANVILLE—Madison†
PRINCETON—Jackson†
SOMERVILLE—Morgan†

Alabama-Mississippi
BISHOP—Colbert

Alabama-Tennessee
ESTILL FORK—Jackson
FISK—Madison
NEW MARKET—Madison

Alaska
BIG DELTA (A-6)* — Fourth Judicial Division†
FAIRBANKS (B-1)* — Fourth Judicial Division†
FAIRBANKS (B-2)* — Fourth Judicial Division†
KODIAK (C-1)*—Third Judicial Division†
VALDEZ (D-5)*—Third Judicial Division†
VALDEZ (D-7)*—Third Judicial Division†

Arizona
ESTRELLA*—Maricopa†
GILA BEND*—Maricopa†
THEBA*—Maricopa†
WINKELMAN*—Gila

Arizona-California
TOPOCK*—Mohave

Arizona-New Mexico
SAN SIMON*—Cochise

Arkansas
ASHDOWN EAST—Little River†
ASHDOWN WEST—Little River†
BEN LOMOND—Sevier
FALLS CHAPEL—Sevier
WINTHROP—Little River

Arkansas-Missouri
SALEM*—Fulton

Arkansas-Texas
OGDEN—Little River

California
CAMARILLO—Ventura†
CAPE MENDOCINO*—Humboldt†
CAPE VIZCAINO*—Mendocino†
DUTCH FLAT—Placer
ESPERANZA SCHOOL—Los Angeles†
GOLETA—Santa Barbara
LEACH LAKE*—San Bernardino
MANLY PEAK*—Inyo
MOUNT GODDARD*—Fresno
NEWBURY PARK—Ventura†
ONION VALLEY—Plumas
OXNARD—Ventura†
PITAS POINT—Ventura
PORT CHICAGO—Contra Costa
QUAIL MOUNTAINS*—San Bernadino†
RIO LINDA—Sacramento
SAVAHIA PEAK*—San Bernardino†
SCOTIA*—Humboldt†

California-Arizona
SAWTOOTH RANGE*—San Bernardino

Colorado
BRACEWELL—Weld
HOYT—Morgan

Connecticut
LYME—New London
WATERBURY—New Haven

Florida
CAPE CANAVERAL—Brevard†
COCOA—Brevard†
COURTENAY—Brevard†
EAU GALLIE—Brevard†
GAP POND—Washington†
GRANT—Brevard†
MELBOURNE EAST—Brevard†
MELBOURNE WEST—Brevard†
ORSINO—Brevard†
POPLAR HEAD—Washington
SEBASTIAN—Indian River
SHARPES—Brevard
VERNON—Washington†
WAUSAU—Washington

Florida-Alabama
ESTO—Holmes

* Indicates 15-minute quadrangle; all others are 7½-minute quadranglès.
† Indicates map lies wholly within county named.
‡ Indicates availability in either a contour or a shaded-relief edition.

Idaho
CLOVER—Twin Falls†
RIGBY SE—Bonneville†
Indiana
ANDREWS—Huntington†
MOUNT ETNA—Huntington
Indiana-Kentucky
JEFFERSONVILLE—Clark
KOSMOSDALE—Jefferson
LANESVILLE—Harrison
NEW ALBANY—Floyd
Kansas
CHANUTE*—Neosho
TOPEKA—Shawnee†
Kentucky
BROOKS—Bullitt
CALEDONIA—Trigg
CHURCH HILL—Christian†
ELKTON—Todd
HOPKINSVILLE—Christian†
JEFFERSONTOWN—Jefferson†
LAWRENCEVILLE—Grant
LOUISVILLE EAST—Jefferson†
OLMSTEAD—Logan
PEMBROKE—Christian
VALLEY STATION—Jefferson
Kentucky-Indiana
ALTON—Crawford
LOUISVILLE WEST—Jefferson
Kentucky-Ohio
VANCEBURG—Lewis
Maine
CUTLER—Washington†
WEST LUBEC—Washington
Maryland-Pennsylvania-West Virginia
ARTEMAS—Bedford
CUMBERLAND—Allegany
EVITTS CREEK—Allegany
Maryland-West Virginia
PATTERSONS CREEK—Mineral
Michigan
GREENLAND*—Ontonagon†
NASHVILLE*—Barry
Minnesota
BIWABIK—St. Louis†
BIWABIK NE—St. Louis†
BIWABIK NW—St. Louis†
McKINLEY—St. Louis†
ST. PAUL PARK—Washington
Mississippi-Alabama
TISHOMINGO—Tishomingo
Missouri
EUGENE*—Cole
HALE—Carroll
NEW BOSTON—Linn
Nebraska
BRISTOW—Boyd
DUSTIN—Holt
NAPER SW—Holt
Nebraska-South Dakota
IRWIN*—Cherry
NAPER—Boyd
Nevada
RENO*—Washoe†
New Jersey
BROOKVILLE—Ocean†
BROWNS MILLS—Burlington
INDIAN MILLS—Burlington†
KESWICK GROVE—Ocean†
WHITING—Ocean
WOODBURY—Gloucester
New Jersey-Delaware
PENNS GROVE—Salem
New Mexico
BIG BURRO MOUNTAINS—Grant†
SILVER CITY—Grant†
WIND MOUNTAIN—Grant†
New York
ANTWERP—Jefferson
BATAVIA NORTH—Genesee†
BRISBEN—Chenango†
DALE—Wyoming
NATURAL DAM—St. Lawrence
OXFORD—Chenango†
POPE MILLS—St. Lawrence†
TYNER—Chenango†
WILLSEYVILLE—Tioga
North Carolina
BROAD CREEK—Pamlico
CHERRY POINT—Craven
HIGH POINT EAST—Guilford
MASONTOWN—Carteret
PELTIER CREEK—Carteret†
SALTER PATH—Carteret†
WINSTON-SALEM EAST—Forsyth
North Dakota
CRARY—Ramsey
DEVILS LAKE—Ramsey
DEVILS LAKE MOUNTAIN—Ramsey
FLORA SE—Wells
FREE PEOPLES LAKE—Benson
FRIED—Stutsman†
GRAHAMS ISLAND—Benson
GRAND HARBOR—Bowie
MENOKEN SW—Burleigh†
MINNEWAUKAN EAST—Benson†
PEKIN NE—Nelson†
PENN—Ramsey
SPIRITWOOD LAKE—Stutsman†
SWEETWATER—Ramsey†
TILDEN—Benson
Ohio-Kentucky
BUENA VISTA—Scioto
Oklahoma
IDABEL—McCurtain†
MARLOW—Stevens
SHULTS—McCurtain†
South Dakota
LA FRANCE—Anderson
ORIENT—Faulk
ORIENT NW—Faulk
ORIENT SW—Hand†
REZAC LAKE NE—Faulk
REZAC LAKE NW—Faulk
Tennessee
CHAPEL HILL—Marshall
FAYETTEVILLE—Lincoln†
FOSTERVILLE—Rutherford
GRAND JUNCTION—Hardeman
JACKSON NORTH—Madison†
LEWISBURG—Marshall†
LINCOLN—Lincoln†
MIDDLEBURG—Hardeman
OBION—Obion†
ROVER—Bedford
WEBBS JUNGLE—Bedford
Texas
ANNONA—Red River
AVERY—Red River
OAK GROVE—Bowie
WHITE ROCK—Red River
Texas-Arkansas
BARKMAN—Bowie
REDBANK—Bowie
Texas-Oklahoma
ACWORTH—Red River
ENGLISH—Red River
DE KALB—Bowie
De KALB NW—Bowie
Utah
AVON SE—Iron†
PAGE RANCH—Iron
SILVER PEAK—Iron†
STODDARD MOUNTAIN—Iron
Virginia
ASHLAND—Hanover
BEULAHVILLE—King William
CAUTHORNVILLE—King and Queen
HANOVER—Hanover
PENOLA—Caroline†
RUTHER GLEN—Caroline
SPARTA—Caroline
STUDLEY—Hanover
YELLOW TAVERN—Henrico
Virginia-West Virginia
EDINBURG*—Shenandoah
Washington
CORFU*—Grant
ELTOPIA*—Franklin
GRANDVIEW*—Yakima
SCOOTENEY LAKE*—Franklin
SMYRNA*—Grant†
West Virginia-Maryland
PAW PAW—Morgan
Wyoming
CODY*—Park†
GRAND TETON NATIONAL PARK*—Teton†
HAUSHAR RANCH—Platte†
MEXICAN PASS SE—Fremont†

In addition to the standard series of quadrangle maps, reconnaissance maps at the scale of 1:250,000 are being published for both the continental United States and Alaska. Maps in this series published in the period include the following:

Alaska
ANCHORAGE‡—Third Judicial Division†
BEECHEY POINT—Second Judicial Division
BERING GLACIER—Third Judicial Division
CHARLEY RIVER‡—Fourth Judicial Division†
DE LONG MOUNTAINS—Second Judicial Division†
FLAXMAN ISLAND—Fourth Judicial Division†
FORT YUKON—Fourth Judicial Division†
HARRISON BAY—Second Judicial Division†
KAGUYAK—Third Judicial Division†
KATEEL RIVER—Fourth Judicial Division
LAKE CLARK‡—Third Judicial Division
MARSHALL—Second Judicial Division
NOME‡—Second Judicial Division†
NORTON BAY‡—Second Judicial Division
NULATO‡—Fourth Judicial Division†
OPHIR—Fourth Judicial Division†
SAGAVANIRKTOK—Fourth Judicial Division
SELAWIK—Second Judicial Division†
SEWARD‡—Third Judicial Division†
SHUNGNAK—Second Judicial Division
Florida
APALACHICOLA
KEY WEST
Montana
BUTTE‡
BOZEMAN‡
WHITE SULPHUR SPRINGS‡
Ohio
COLUMBUS
MARION
TOLEDO
Oklahoma-Arkansas
McALESTER
Virginia
RICHMOND
Virginia-West Virginia
CHARLOTTESVILLE‡

CONGRESS NEWS

Officers and Committee Chairmen for 1952

The appointment by the President of the American Congress on Surveying and Mapping of the following officers and committee chairmen, to serve for the calendar year 1952, has been approved by the Board of Direction:

Officers

Walter S. Dix, *Executive Secretary*
Richard T. Evans, *Treasurer*
Aaron L. Shalowitz, *Editor-in-Chief*
Robert C. Eller, *Assistant Editor*

Committee Chairmen

Kenneth T. Adams, *Publications* and *Budget and Finance*
Frank S. Borden, *Membership*
Chester E. Kowalczyk, *Annual Meeting*
Alfred C. Stiefel, *Public Relations*

Mr. Shalowitz, who has served as Editor-in-Chief for the past 10 years, has kindly agreed to continue in that capacity, in spite of increasing demands upon his time by his professional occupation, until such time as the newly-appointed Assistant Editor, Robert C. Eller, becomes familiar with, and is able to assume, the editorship. Mr. Shalowitz has further agreed to serve in an advisory capacity after that time. Mr. Eller is a cartographer with the Trimetrogon Section of the Topographic Division, U. S. Geological Survey, and was previously employed by the County Surveyor, Mineral County, Montana.

GEORGE H. HARDING
President

Twelfth Annual Meeting ACSM

Planning for the Twelfth Annual Meeting of the American Congress on Surveying and Mapping, which will be held at the Shoreham Hotel, Washington, D. C., June 11, 12, and 13, 1952, has gotten off to an early start with the appointment of Chester Kowalczyk as general chairman. L. Ray Smart will be deputy general chairman and Alfred C. Stiefel will serve as consultant to the committee. The Program Committee will be headed by Arthur Sweet, assisted by the heads of the six technical divisions of the Congress. Each technical division will be responsible for a portion of the program to insure a diversified agenda that will serve the interests of all members of the Congress.

The Exhibits Committee for the annual meeting is in charge of Emory Hall who did such an excellent job last year as head of the committee which arranged for the display of the activities of the Federal mapping agencies. The Exhibits Committee is again inviting commercial concerns to display their newest equipment and supplies so that you may see and learn about the latest developments in this field. Last year a number of new companies were represented and we are again expanding the amount of space allotted to commercial exhibitors. This policy affords increasing opportunity for our members and the industries which serve our many requirements to make contacts that are mutually desirable and profitable. Plan to attend and inspect these exhibits

so that you may see what is new in equipment and supplies.

The Annual Meeting of the ACSM provides an opportunity for its members to hear well-known and authoritative speakers on subjects that deal with all phases of surveying and mapping. Prominent speakers are being lined up to address the Congress on timely subjects, and opportunity will be afforded for discussion.

All technical meetings will be held during the morning and afternoon sessions so that the evenings will be available for renewing friendships, making new contacts, and enjoying the social activities which will include a cocktail party, the annual dinner, and a dance. Members are encouraged to plan their vacations at the time of the annual meeting and to bring their wives.

—ALFRED C. STIEFEL, *Chairman*
Public Relations Committee

Topography Division Notes

MAPPING ALONG INTERSTATE HIGHWAYS SYSTEM

The resolution passed at the Eleventh Annual Meeting of the American Congress on Surveying and Mapping regarding topographic mapping along the National System of Interstate Highways (Vol. XI, No. 3, p. 311) was implemented by the appointment of J. C. Carpenter, Supervising Highway Transport Research Engineer, Bureau of Public Roads, as chairman of a committee "to encourage Nation-wide interest in topographic mapping as an effective aid in the development of economic locations for State and Federal highways." The committee now includes the following representatives of the mapping agencies: Capt. H. W. Hemple, Chief, Division of Geodesy, U. S. Coast and Geodetic Survey; Robert H. Lyddan, Chief, Plans and Coordination Branch, Topographic Division, U. S. Geological Survey; and Col. John G. Ladd, Commanding Officer, Army Map Service. The appointment of representative highway engineers to complete the committee has not yet been made.

The proposed project was explained to the American Association of State Highway officials at their meeting in Omaha, Nebr., on October 23, 1951. As interest in the idea develops, it is anticipated that the committee will be augmented to include highway engineers who will develop working programs to provide the necessary topographic maps in sufficient time to allow their use in highway survey projects.

NORTHERN CALIFORNIA SECTION

As reported at the Annual Meeting, a Discussion Group was organized in Sacramento to promote interest in the Congress. The immediate and enthusiastic acceptance of the idea prompted their petition for charter as the Northern California Local Section. The Group has complied with all requirements, and its proposed Constitution and Bylaws have been approved by the Executive Committee for the Board of Direction of the Congress. The Discussion Group, therefore, has become a Section. Congratulations are in order, particularly to its chairman, Mr. Vernon A. Seward.

The bylaws of the Section provide for semi-annual meetings, one in San Francisco and one in Sacramento. The fall meeting was held November 16 at the City College of San Francisco, with an attendance of 35 members and 60 guests. Mr. C. J. Aggeler, Instructor in Engineering at the City College, addressed the Group on the subject "What Do You Believe Essential in Education for Surveying and Mapping?" This meeting was the first related to the American Congress on Surveying and Mapping to be held in the Bay area.

An announcement of another meeting, held on December 4, in Sacramento, is quoted in part as follows:

"Many of you will recall that 46 of us met about a year ago to organize a Group within the Geological Survey that would endeavor to broaden the knowledge of topographic mapping and promote interesting discussions relating to : (*a*) articles from the Journal of American Congress on Surveying and Mapping, (*b*) different phases of surveying and mapping from personal experiences, and (*c*) topics of general interest selected by the members. The idea, like many good ones, grew like a mushroom and will become the Northern California Section of ACSM before 1952. This is good for all concerned, but leaves our

Discussion Group with the feeling that Junior has grown up and left home.

"What shall we do? It has been suggested that we move in with Junior by organizing a Topographic Surveys Technical Group within the Northern California Section, ACSM. The Group would carry out the original idea and although membership would not be limited to Geological Survey employees, the name should insure against drifting too far afield.

"The business part of this meeting will be devoted to the Organization of a Topographic Surveys Technical Group and should be of interest to all of us. . . ."

C. S. MALTBY
Chairman

Control Surveys Division

INFORMATION URGENTLY NEEDED

This year it is the policy of the Technical Division on Control Surveys to place emphasis upon the extension of control surveys beyond the scope of Federal agencies. An endeavor will be made to make surveyors throughout the country more cognizant of what is being done to enlarge upon the basic control in their own state and at the same time to give the unit in question a better chance to see the problem as a whole as it affects the cities of the country at large. By thus broadening our point of view, it is believed that the work of government bureaus can become more effective, while at the same time surveyors throughout the country may learn how to make the best use of the foundation already laid.

In planning the program for the coming Annual Meeting, it is important to obtain as complete a list as possible of all agencies, local or state-wide, engaged in assembling control data. Some states have authorized state bureaus dealing with maps and surveying and some of these are already very active in doing progressive work. In some instances, it is the city or county unit which has taken the initiative. Undoubtedly, many private organizations may be in a position to render valuable service. The Control Surveys Division wants as complete knowledge as it can get regarding these agencies, what they are doing, and particularly what experience they can contribute toward the general effort of promoting good practice. Consequently, this is an appeal to all members of the Congress to send the answer to one question to the Secretary of the Division, Mr. C. A. Whitten, U. S. Coast and Geodetic Survey, Washington, D. C.: WHEN YOU NEED CONTROL DATA, TO WHAT AGENCY OR AGENCIES DO YOU APPLY?

Please do your part in making this roster complete, so that we may canvass all sources of information for methods to make the most effective use of control surveys.

CARROLL F. MERRIAM
Chairman

Annual Meeting, Southern California Section

On December 11, 1951, the Annual Meeting of the Los Angeles Section of the American Congress on Surveying and Mapping convened at the Carolina Pines Restaurant.

The meeting proved to be a most interesting one, for as the evening progressed the Los Angeles Section was changed to be Southern California Section, official approval to make this name change having been first secured from the Executive Committee, ACSM.

Next, a new constitution and by-laws befitting the new change was introduced and, after some discussion, was adopted.

The Nominating Committee then presented its recommendation for the officers for 1952. The entire panel as presented was elected and installed in office. They are as follows:

Officers

H. Fred Peterson, *Chairman*
Henry H. Beitler, *Vice Chairman*
William Meek, *Treasurer*
Forrest M. Burke, *Secretary-Editor*

Directors

William C. Wattles
Daniel E. Whalen, Jr.
R. B. Huey

Chairman Peterson appointed chairmen for the Standing Committees, as follows:

Paul E. Roth, *Membership*
John E. Asher, *Public Relations*
George Greenwald, *Program*
E. L. Chapin, Jr., *Technical Divisions*
T. R. Humes, *Education*

FORREST M. BURKE
Secretary-Editor

Personals

Michael Baker, Jr., Inc., has announced the appointment of Charles L. Miller as Assistant to the District Engineer, Southern Operations, Jackson, Mississippi. Mr. Miller, a recent graduate of the Massachusetts Institute of Technology, has been associated with the Baker Engineers since 1945, working during the summers on numerous field projects. He is a member of the American Congress on Surveying and Mapping, the American Society of Photogrammetry, and a Junior Member of the American Society of Civil Engineers.

Lester C. Higbee, 1951 Chairman of the Division on Surveying Instruments of the American Congress on Surveying and Mapping, was recently elected president of W. & L. E. Gurley, Troy, New York, a sustaining member of the Congress and America's oldest manufacturer of engineering and scientific instruments. Mr. Higbee becomes the fifth president in Gurley's 107-year history.

Prior to his election, Mr. Higbee served as Director of Engineering and General Sales Manager, as well as secretary of the company. He joined Gurley in 1915, serving successively as production engineer, office manager, salesman, advertising manager, development engineer, and sales manager, and was appointed to the Board of Directors in 1948.

Captain H. W. Hemple, Chairman of the Control Surveys Division of ACSM from 1947 to 1949, and A. L. Shalowitz, Editor-in-Chief of SURVEYING AND MAPPING, received gold medals and citations on February 19, 1952, at the Fourth Honor Awards Program of the United States Department of Commerce "for outstanding service rendered the public service, the Nation, or humanity."

MISSISSIPPI RIVER MAPS

The Mississippi River Commission has announced a folio of new maps of the Mississippi River from the mouth of the Arkansas River to Vicksburg, Mississippi. The folio comprises 77 maps at a scale of 1:20,000, size 14½ by 22 inches, and includes a smaller scale index map of the series. The topographic bases are mosaics prepared from aerial photographs taken in November–December 1948; soundings in the river are from hydrographic surveys made in 1948–49. The mosaics cover from 1 to 2 miles on each side of the river. The maps are reproduced in black and white.

Copies of the folio are obtainable from Mississippi River Commission, P. O. Box 80, Vicksburg, Mississippi; price $1.50 per folio.

Annual Financial Statement

(As of December 31, 1951)

INCOME

Dues and memberships received	*1950*	*1951*	*Year ending 12/31/50*	*Year ending 12/31/51*	*Differences*
Individual	1323	2262	$7,204.43	$11,284.28	
Library	168	198	726.05	862.66	
Sustaining	14	18	350.00	430.00	
Subscriptions	1	0	4.00	0.00	
Previous year's dues	0	0	91.91	45.00	
Total	1506	2478			
Total gross regular income			$8,376.39	$12,621.94	+ $4,245.55
Deduct membership costs			*– 788.31*	*– 1,665.34*	
Net regular income			$7,588.08	$10,956.60	+ 3,368.52
Publication sales			205.18	185.21	*– 19.97*
Annual meeting and other income			751.53	156.34	*– 595.19*
OPERATING INCOME			$8,544.79	$11,298.15	+ $2,753.36

EXPENDITURES

Journal (all expenses)	$5,432.13	$ 7,892.83	+ $2,460.70
Other printing	91.20	56.85	*– 34.35*
Office supplies and Secretary's and Treasurer's expenses	1,017.95	526.78	*– 491.17*
Technical Divisions	158.99	168.28	+ 9.29
Other expenditures authorized by the Board of Direction	120.49	24.00	*– 96.49*
TOTAL EXPENDITURES	$6,820.76	$ 8,668.74	+ $1,874.98
SURPLUS (or deficit)	+ 1,724.03	+ 2,629.41	+ 905.38

ASSETS

Bank balance	$2,123.49	$ 5,392.48	+ $3,268.99
Bonds and Savings Account	4,055.00	7,055.00	+ 3,000.00
Journal (back issues—estimated)	300.00	300.00	0.00
Emblems (at cost)	20.09	0.00	*– 20.09*
Advance payments	208.11	483.02	+ 274.91
Accounts receivable	9.50	0.00	*– 9.50*
TOTAL ASSETS	$6,716.19	$13,230.50	+ $6,514.31

LIABILITIES

Advance dues paid	$1,809.00	$ 3,901.90	+ $2,092.90
Oct.–Dec. Journal	0.00	1,800.00 (est.)	+ 1,800.00
Other accounts payable	8.00	0.00	*– 8.00*
TOTAL LIABILITIES	$1,817.00	$ 5,701.90	+ $3,884.90
NET WORTH	**$4,899.19**	**$ 7,528.60**	**+ $2,629.41**

K. T. ADAMS, *Chairman*
Budget and Finance

Something About Our New Members

This issue of the Journal contains a list of members who joined the Congress during the last quarter of 1951. An analysis of some of the information submitted with their applications for membership may be of general interest.

This group of new members came from 33 states, Alaska, Hawaii, the Canal Zone, and 5 foreign countries. Comparisons of the percentages from the various states would be misleading, since special canvasses made in North Carolina and Pennsylvania during October and November increased appreciably the percentage of new members from those two states. California, Missouri and Texas maintained their excellent percentages, due in large part to the untiring efforts of enthusiastic members in those states.

Of the 190 new members listed, 178 expressed, in order of preference, their interest in various branches of surveying and mapping. Considering only the first preferences, we find that property surveys leads the way with 42 percent of the total. Topography, including aerial surveys, is second with 22 percent, followed by cartography with 16 percent, control surveys with 9 percent and construction surveys with 5 percent. The remaining 6 percent is divided almost equally between geophysical surveys, surveying education, and surveying instruments. A slightly more accurate picture might have been obtained by giving weight to second preferences. The principal effect of this procedure would have been to increase topography slightly and decrease cartography a corresponding amount.

The occupations of the new members included registered engineers and surveyors engaged on city, highway, sanitary, forestry, transportation line and power company projects, as well as many registered surveyors engaged in private practice or employed by engineering concerns. In addition to a large number of cartographers and draftsmen, there were geodesists, photogrammetrists, computers, geologists, and geographers. The educators ranged from the head of a civil engineering department to instructors in civil engineering and geography. The new member with apparently the widest range of duties stated his occupation to be: "R.R. Telegrapher, Towerman, and Registered Surveyor."

The ratio of governmental organizations to private organizations was seven to eleven. The former accounted for county surveyors, city engineers, state highway and public works departments, state universities, federal surveying and mapping agencies, and military organizations. The U. S. Geological Survey led all governmental organizations by a wide margin. The private organizations were made up largely of engineering, surveying, and mapping companies, oil companies, map reproduction plants, utility companies, railroads, lumber companies, paper companies, and one powder company.

Special interests, as expressed on the applications, included municipal engineering, farm engineering and surveys, assessor's maps of rural areas, certified standardization of surveying equipment, water and sewer systems, riparian rights, underground surveys, map projections, map relief, plastic relief maps, state control systems, vacancy checking, and petroleum and natural gas exploration.

A few extracts taken from the applications and related correspondence follow:

From New York—"I have a great interest in your quarterly publication, both as a computer for the civil engineering firm of Vanderwater and Lapp, Far Rockaway, New York, and as a licensed chief officer in the merchant service with a great interest in marine surveying and hydrography." (Mr. Vanderwater and Mr. Lapp are also members of the Congress.—Editor.)

From Minnesota—"I do believe it (ACSM) is going to fill a long wanted place in my engineering societies. I also hope to be able to attend your convention in Washington this summer. . . . I received the indexes and find there are so many articles I would like to digest that I wish to purchase all of the volumes published to date. . . . I would like to receive a few application blanks, as I believe there are quite a few prospects in this vicinity."

From Arkansas—"Am 79 years old, need to learn more about surveying; 56 years in the work."

FRANK S. BORDEN, *Chairman*
Membership Committee

TWELFTH ANNUAL MEETING, JUNE 11–13, 1952, WASHINGTON, D. C.

NEW MEMBERS

INDIVIDUAL MEMBERSHIPS

ABBOTT, J. H., 801 Pine St., Crossett, Ark.—Engineer, Town Div.

ADAMS, L. Mabry, Route #2, Cleburne, Tex.—Architect and Civil Engineer

ALI, Ahmin, Civil Engineering Dept., Ohio University, Athens, Ohio—Instructor

AMSTADT, John M., 3020 S. Abingdon St., Arlington, Va.—Budget Officer, USC&GS

ANDREWS, Alvin P., P. O. Box 1206, Monroe, La.—Area Engineer, Dept. of Public Works, State of La.

ANDREWS, G. S., Surveys and Mapping Service, Dept. of Lands and Forests, Parliament Bldg., Victoria, B. C., Canada

ANGSTADT, Oren, 20 Park Lane, Pennside, Pa.—Transmission Line Engineer, Gilbert Associates, Inc.

ARMSTRONG, Charles T., 2616 Roosevelt Blvd., Midland, Tex.—Land Surveyor, Shell Oil Co.

BALL, Fred A., 29th Engr. Base Topo Bn., APO 928, c/o Postmaster, San Francisco, Calif. — Topographic Surveyor, U. S. Army

BARKLEY, Robert J., Hercules Powder Co., Delaware Trust Bldg., Wilmington, Del. — Civil Engineer

BARNES, James A., Dept. of Geography and Geology, University of Georgia, Athens, Ga.—Assistant Prof. of Geography

BARTMAN, Raymond C., Jr., P. O. Box 346, Sacramento 2, Calif.—Cartographic Compilation Aid, USGS

BECK, Ellis L., Route #1, Box 202, Jeannette, Pa.—Cartographer, C. Edward Long, Consulting Engineer

BISEL, Ralph E., Box 1004, 10 Nantahala St., Badin, N. C.—Civil Engineer and Chief Draftsman

BRAUCHER, Samuel L., 42 Carlton St., Sodus, N. Y.—Registered Surveyor

BRAWNER, William M., P. O. Box 31, Paragould, Ark.—Office Engineer, Corps of Engineers

BRIENZA, Paul L, City Hall, Mt. Vernon, N. Y.—City Engineer

BRIGGS, Roy, 76 Forest View Dr., San Francisco, Calif.—Instructor in Engineering, City College of San Francisco

BROWN, Merrill A., East St., Carlisle, Mass.—Engineer and Land Surveyor

BRUSH, D. V., Box 109, R. D. #2, Verona, Pa.—Engineer, The Manufacturers Light & Heat Co.

BUCHANAN, W. Franklin, 405 Main St., Metuchen, N. J.—Civil Engineer and Surveyor

BURT, J. R., P. O. Box 730, Trenton, N. C.—County Surveyor, Jones County

BURTON, W. A., 803 E. 4th St., Mt. Pleasant, Tex.—Chief Engineer, Paris & Mt. Pleasant R. R. and Titus County Surveyor

BUSSELL, Conrad T., 234 N. Granada St., Arlington, Va.—Organization and Methods Examiner, Labor Dept.

CABRAL, Dr. Edson, Servicos Aerofotogrametricos Cruizeiro do Sul, Av. Pasteur 429, Rio de Janeiro, Brazil

CARMICHAEL, Paul J., P. O. Box 133, Rolla, Mo.—Topographic Engineer, USGS

CAROTHERS, Lee E., Route #1, Pineville, N. C.—Registered Land Surveyor

CARR, J. Revell, 12 Church Circle, Annapolis, Md.—Registered Land Surveyor

CAVIN, W. Marsh, Stanley, N. C.—Bank Manager and Surveyor

CHOPE, Irvin E., 11742 Bramell St., Detroit 28, Mich.—Engineering Asst., Wayne County Drain Commissioner

COHEN, Philip M., 1439 Oglethorpe St., N. W., c/o Rein, Washington, D. C.—Cartographic Aid, Army Map Service

CONANT, Louis C., USGS, Northington Campus, University of Ala.—Supervising Geologist

COOPER, Ousby L., Box 668, South Hill, Va.—Materials Engineer, U. S. Army, Corps of Engineers

COTE, Daniel N., 809 Forest Glen Rd., Silver Spring, Md.—Surveyor, USGS

COX, David, Jr., Hertford, N. C.—Land Surveyor

CROSS, Dick L., P. O. Box 346, Sacramento 2, Calif.—Surveying and Cartographic Aid, USGS

CUBBAGE, James M., P. O. Box 784, Point Marion, Pa.—Surveyor

DEAN, Donald H., 408 California Fruit Bldg., Sacramento, Calif.—Surveyor, Joseph E. Spink, Registered Engineer

DELANEY, Albert E., 116 Victoria Rd., Burlingame, Calif.—Cartographic Engineer, Corps of Engineers

DINNIN, Mrs. Leona C., P. O. Box 346, Sacramento, Calif.—Cartographic Draftsman, USGS

DONAHEY, Walter L., 138 Center St., St. Marys, Pa.—Engineer, Pa. Dept. of Highways

DONAN, John G., 60 E. Center St., Madisonville, Ky.—Civil and Mining Engineer

DOSCHER, George E., 513 Beachwood Blvd., Beachwood, N. J.—Structural Supervisor, Geo. A. Fuller Co.

DUMBLE, Charles S., 234 Olive St., Bakersfield, Calif.—Civil Engineer, County Surveyor

EAKES, J. Chandler, Jonesboro Heights, Sanford 8, N. C.—County Surveyor, Lee County

ELLER, Robert C., U. S. Geological Survey, Washington 25, D. C.—Cartographer

ELLIS, Lewis L., 207 Gold Professional Bldg., Wilson, N. C.—Land Surveyor

EMMINIZER, Granville K., Jr., 1233 Patapsco St., Baltimore, Md.—Asst. Chief of Aeronautical Chart Br., USC&GS

ERB, Rowland W., 1210½ 7th Ave., Neptune, N. J.—Senior Engineer, N. J. State Highway Dept.

EUBANK, B. J., 2056 Chippewa St., Baton Rouge, La.—Party Chief, Geophysical Div., The Texas Co.

EVERS, William E., P. O. Box 384, Deer Park, L. I., N. Y.—Licensed Land Surveyor

FARRAR, A. K., Centreville, Miss. — County Surveyor, Wilkinson County

FOX, Tom, Jr., 2093 Louis Rd., Palo Alto, Calif.—Asst. Highway Engineer

FRANKENFIELD, Howard B., Jr., P. O. Box 1103, Tryon, N. C.—Forest Engineer and Surveyor

FUNK, L. L., P. O. Box 841, San Luis Obispo, Calif.—Asst. Dist. Engineer, Calif. Div. of Highways

GEURIN, Johnnie W., Box 133, Rolla, Mo.—Photogrammetric Engineer, USGS

GILBERT, R. E., 1203 Central Ave., Albany, N. Y.—Owner, R. E. Gilbert Surveys

GLASS, Richard A., R. R. #2, Box 104, Indianapolis, Ind.—Registered Surveyor

GOLDSMITH, Woodrow W., Box 584, Mt. Airy, N. C.—Civil Engineer

GOLUB, Harvey, Alaska Road Commission, Juneau, Alaska—Highway Engineer

GORDON, James B., 725 Ellis St., San Francisco, Calif.—Cartographic Engineer, Corps of Engineers

GRAFF, J. Edwards, 1621 N. Calvert St., Baltimore 2, Md.—Civil Engineer, Rummel, Klepper & Kahl

GRAHAM, John P., P. O. Box 1249, Houston 1, Tex.—Engineer, Standard Oil Co. of Tex.

GRAMBO, Amos S., Bonneville Power Adm., P. O. Box 3537, Portland, Oreg.—Chief of Party

GRIMM, William W., 5724 Kenneth Ave., Carmichael, Calif.

HALL, Harold S., Box 133, Rolla, Mo.—Topographic Engineer, USGS

HAMILTON, Mrs. Barbara A., P. O. Box 346, Sacramento, Calif.—Cartographic Draftsman, USGS

HARRIS, Millard H., Alabama Power Co., 600 N. 18th St., Birmingham 2, Ala.—Manager, Major Projects Construction

HAZARD, Thomas A., Ryall Engineering Co., 5th Ave. Hotel, Fairbanks, Alaska—Field Engineer

HEBB, Lyle E., Box 399, Bassett, Nebr.—Associate Engineer, State of Nebr.

HEFFNER, Irvin R., 235 North St., Emmaus, Pa.—Railroad Telegrapher and Towerman and Registered Surveyor

HEIDT, Mack, 1st National Bank Bldg., Julesburg, Colo.—Surveyor, Midwestern Geophysical Lab.

HEINRICHS, Christian C., c/o General Geophysical Co., General Delivery, Aransas Pass, Tex.—Computer, General Geophysical Co.

HENNINGSEN, J. N., P. O. Box 133, Rolla, Mo.—Topographic Engineer, USGS

HILL, William B., Jr., 212 Dixie Ave., Wilmington, N. C.—Land Surveyor, International Paper Co.

HULME, J. C., P. O. Box 1482, Athens, Ga.—Highway Project Engineer

HUTCHISON, Frank L., Route #3, Candler, N. C.—Resident Engineer, N. C. State Highway & Public Works Commission

JACKSON, Gorham E., 604 W. Main St., Beaufort, N. C.—Consulting Forester

JAMES, Charles A., P. O. Drawer 2100, Houston, Tex.—Civil Engineer, Gulf Oil Corp.

JENKS, Dr. George F., University of Kansas, 419 Lindley Hall, Lawrence, Kans.— Asst. Prof., Dept. of Geography

JOHNSON, Ralph S., McNair Investment Co., Laurinburg, N. C.—Forester

JOHNSTON, Henry M., Jr., Box 133, Rolla, Mo.—Topographic Engineer, USGS

JONES, Charles R., Court House Annex, P. O. Box 369, Livingston, Tex.—County Surveyor, Livingston County

JONES, George K., 102 Woodworth St., Sayre, Pa.—County Surveyor, Bradford County

JONES, Morris R., 21 Great Oaks St., Rolla, Mo.—Topographic Engineer, USGS

KERR, John J., 6763 Thomas Blvd., Pittsburgh 8, Pa.—Chief of Party, Allegheny County Sanitary Authority

KIRCHNER, Charles L., P. O. Box 712, Curundu, C. Z.—Geodetic Engineer, Inter-American Geodetic Survey

KNICKERBOCKER, Howard, Salisbury, Conn.—Registered Land Surveyor

KNIPPEL, Paul R., Route #57, Troy, N. Y.—Asst. Treasurer, Rensselaer Polytechnic Institute

KONIKOWSKI, Edward G., 159 Wallington Ave., Wallington, N. J.—Engineer and Land Surveyor

KRAMLICH, Richard F., 1208 Union St., Allentown, Pa.—Chief of Party, G. Edwin Pidcock Co.

KRONK, Morgan E., 1803 Boundary St., Aliquippa, Pa.—Cartographic Aid, USGS

KUHN, Aloys, Nagogami Rd., Rolla Mo.—Surveying and Cartographic Engineer, USGS

KURRLE, Alan F., 60 Manning Rd., East Malvern, Victoria, Australia—Surveyor, Dept. of Civil Aviation

LAMBELET, Lawrence E., 1001 Lynwood Dr., Rolla, Mo.—Topographic Engineer, USGS

LAMBERT, Walter D., P. O. Box 687, Canaan, Conn.—Mapping & Charting Research Laboratory, Ohio State Univ.

LANDERS, Walter, Public Works Bldg., Sacramento, Calif. — Chief Draftsman, Headquarters Office, Calif. Div. of Highways

LANG, J. Howard, P. O. Box 1352, Fresno, Calif.—Assoc. Highway Engineer, State of Calif.

LEMOINE, Jules C., U. S. Geological Survey, Box 1264, Bay City, Tex.— Cartographic and Survey Aid

LEONARD, E. C., 305 Cameron Ave., Chapel Hill, N. C.—Surveyor

LEONARD, Robert H., P. O. Box 133, Rolla, Mo.—Topographic Engineer, USGS

LEVY, Sam Francis, 567 31st St., Oakland 9, Calif.—Surveying and Cartographic Engineer, Public Works Office, 12th Naval District

LINN, Gladys G., P. O. Box 346, Sacramento, Calif.—Cartographic Draftsman, USGS

LITTLE, Robert E., P. O. Box 133, Rolla, Mo.—Topographic Engineer, USGS

LOLLICH, P. M., Pennsylvania Game Commission, Harrisburg, Pa.—Game Land Engineer

LOSAK, George, 6 Court "S," Lake Village, Wilmington, N. C.—Registered Land Surveyor

LOVELL, Carl V., 76–80 Mill St., Port Allegany, Pa.—Chief of Surveys, North Penn Gas Co.

LUPO, John M., Jr., Direct Reproduction Corp., 811–813 Union St., Brooklyn, N. Y.—Vice President

LUQUIRE, Joseph W., Jr., Luquire Engineering Co., 255 St. Francis St., Mobile, Ala.—Civil Engineer and Land Surveyor

MacCARTHY, R. E., Rm. 18, Clark Bldg., Main St., Natick, Mass. — Owner, MacCarthy Engineering Service

MADSON, Carlisle, 3035 Oregon Ave., St. Louis Park 16, Minn.—Survey Crew Chief, Village of St. Louis Park

MAKAR, Orest, Dr. Eng., 916 Decatur St., N. W., Washington 11, D. C.—USGS

McADAMS, J. Mark, Williamson Ave., Elon College, N. C.—Registered Surveyor

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